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ne Recent British Tests of Suction-Gas Plants.

he nominal advantages of suction-gas plants small capacity are so numerous that the Royal icultural Society of England, which has made y trials of agricultural mechinery, decided to them at its Derby show last June. What Society wished to ascertain was stated in the ulations regarding the trials to be the attendance required, the general design of the plant and the facility with which it could be cleaned, its regularity of working, the fuel and water consumption, the price, the relative proportions of the gas producer and engine, and the volume swept by the piston relative to the brake-horse-power. The size of the plant was to be between 15 and 20 h.-p., which is most suitable for agricultural purposes, and eleven plants were tested their operation during the trials being under the charge of their makers' representatives. The report of the judges, Capt. H. Riall Sankey and Prof. W. E. Dalby, was made public a few weeks ago, and states that a good plant, working continuously at full load under favorable conditions, ought to furnish a brake-horse-power with a consumption of 1.1 lb. of anthracite on 1.3 lb. of coke of the grades used during the tests. There seems to be no disposition to question this statement, but strong objection has been raised to many of the judges' detailed comparisons between the plants tested. There are good grounds for some of these objections, and in order that the method of conducting the trials may not be considered a standard one for similar tests on this side of the Atlantic, some of its defects will be pointed out.

In the first place the time allowed for the trials was too short to prove anything of value concerning the reliability of the apparatus. The trials were started at 9 A. M., June 18, and began with full-load tests, using anthracite as a fuel. The producers were empty, and the time of starting each engine and getting on the full load from the moment of laying the fire was duly recorded. Each plant was run for 9 hours and then stopped. The hopper and fire-doors of every producer were then sealed; during the night the fires were banked. Next morning the plants were started, the time elapsing between starting and putting on full-load being recorded. The full load was maintained for five hours, after which the engines were stopped, the fires drawn, and the partially burned fuel placed in iron vessels for weighing and examination. This completed the full-load anthracite trials, which accordingly consisted of nine hours full-load, fourteen hours banked fires and five hours full-load. A half-load trial was carried out on June 20, a variable load trial the next day and a full-load coke trial on June 22. Such tests as these show something of the fuel consumption of such plants under the most favorable conditions, provided the unconsumed fuel at the end of such a short trial can be correctly estimated. The uncertainty in this respect is so great, however, that it throws a shadow of unreliability over even such results. As for furnishing any information about the reliability or regularity of working of a suction-gas plant, the tests were simply a snare and a delusion, in spite of the voluminous tables in which the results are recorded.

In order to know what such a plant will do on a given fuel it is necessary to run it at least a week; unless this is done there is no way to ascertain the effect of the gas on the engine, which is not indicated in a shorter time. It is also impossible in such a short run to find out what the requirements of maintenance will be, because the plants do not reach a condition in a couple of days' working which makes cleaning at all serious. In testing any kind of machinery during a short run, it is pretty well settled that a fine showing can be made even with hopelessly bad apparatus if it is put in the hands of the maker's representatives. Such spurts simply prove how well the maker's men can groom down the engine for a quick dash. What people who buy suction-gas plants for agricultural and like purposes wish to know is what amount of attendance and repairs is needed when the equipment is handled by the class of men to whom the care of such apparatus will be assigned. It is the easiest thing in the world to set up a skimpy producer and a rattle-trap engine in such a way that it will make a pretty good showing in such a trial and rank high on account of its low price, but we beg to be excused from making the contraption work steadily. The trouble to-day with such plants on farms, so far as this journal has been able to learn, is that they do not have sufficient producer capacity and the engines are so built that it takes a better man than is usually available on the farm to clean them. The many plants working well when well designed and handled show what can be done. Very little can be learned, however, by such tests as those run by the Royal Agricultural Society.

Committee and Research Work by Societies.

Now that the four great national engineering societies are all provided with ample permanent headquarters which give them a certain standing that no organization can possess which makes its home in an office building or made-over dwelling house, it is only fair to assume that those responsible for their management will not be content with provisions which are directly useful only to the local members and the employes, but will endeavor to increase the returns which membership confers on those who are not resident in the New York district. The publications of all these societies are extremely valuable and in themselves well worth the annual dues; but there are other things such bodies can do than publish papers. In fact, the thing they can best do is not the annual production of several volumes of technical papers, but the organization of research and committee work. This is shown, in fact, by an impartial examination of what the societies have already accomplished. The American Society of Civil Engineers, for instance, has done more real lasting good through its committees on rail sections and cement than by any other single means. In the same way the standardization brought about by the American Institue of Electrical Engineers and the development of uniform methods of testing steam plant due to the American Society of Mechanical Engineers have been of marked direct value.

This feature of society work has been developed far more in other countries than here, although the most important single example of it is probably afforded by the American Railway Engineering and Maintenance of Way Association, which is given up almost exclusively to committee work and the discussion of committee reports. Very likely one reason for this condition in America is that the territorial extent of the country is so great that it takes a large amount of time for members of a committee representing different parts of the country to get together. Where committeemen must devote several days and a considerable sum for traveling expenses to attend each meeting they are likely to be entirely willing to have other men take up the work. This is particularly true when their meetings are taken up mainly by wrangles between those members representing manufacturing companies and those representing purchasers. Nevertheless there is a certain field of marked usefulness which the national engineering societies can cultivate with much profit to the members, if the work is taken up carefully and methodically. Perhaps the best way of indicating what can be done is to mention a single example of what a small German organization is accomplishing.

The German Society of Gas and Water Engineers is an association devoted exclusively to water and gas affairs and accordingly limited in membership and resources. It nevertheless maintains committees on photometry, gas-meters, heating, electrolysis, standards, the standardization of gas-holders, technical education, water-works methods, and the German Technical Museum, all of which are granted funds for carrying on their work. It has further appropriated for this year $750 for research work in the laboratory of the Carlsruhe Technical Institute under the direction of Dr. Bunte, its eminent secretary, a like sum for statistical work relating to gas works and a like sum for similar work respecting water works. The appropriation to be spent by Dr. Bunte enables him to carry out investigations in the excellent laboratory under his direction which otherwise would have to remain in the background until special appropriations could be secured for them; it is understood that this research is one of the most successful features of the society's work, doubtless owing to Dr. Bunte's long association with gas and water-works and his admirable fitness for such investigations. A great deal of investigation is done by the committees also, and some of their reports have attracted wide and favorable attention. As a rule these research committees are appointed to investigate a problem that several members are struggling with at the same time; past experience has shown that in the counsel of many lies wisdom, and so those members best qualified to investigate the subject are appointed a committee to do so. The greatest work the society has ever undertaken has only recently been started. It is the construction and operation of an experimental gas works on the grounds of the municipal plant at Carlsruhe. It will be managed by Dr. Bunte and his staff and the gas and by-products will be taken over by the city works. It is believed that such a testing plant will furnish information of the highest technical value, and will also afford exceptionally good opportunities for instructing students in the regular classes at the Carlsruhe Polytechnic Institute and gas-works foremen who wish to utilize their holidays in securing a better knowledge of the scientific features of their work.

In suggesting that work of this sort might be profitably undertaken on a larger scale than in the past by American societies, this journal does not desire to intrude its advice upon those responsible for the management of these organizations and merely intends to put on record an opinion expressed of late in a number of letters from engineers whose remoteness from New York makes it impracticable for them to share except in spirit the advantages of the admirable homes in which the societies are now located. There seems to be a feeling that now all of them are through with the cares and worries of house-building, there is probably an opportunity for more and better committee work, which will either furnish useful technical data or will assist in standardizing certain features of engineering work in which it has been customary for too long for each engineer to be a law unto himself.

Reinforced Concrete Building Failures.

The failure of reinforced concrete structures is a subject already well worn and an apology is almost in order for editorial comment on most instances of this class. Although these comments are to be of a general character and intended to aid in enforcing right principles of construction, the special reference is to the failure of the Eastman Kodak Co.'s building, near Rochester. This failure has been the subject of official investigation and the judgment of experienced experts has been given in a report published in The Engineering Record of Feb. 2. While light has been thrown upon the condition of the work prior to the failure, it is perhaps natural that there should be marked diversity of opinion as to the real causes of the collapse. In fact the tendency is to make more or less of a mystery of such things, as was the case many years ago with boiler explosions, wittingly or unwittingly overlooking some simple and effective conditions sufficient to explain rationally all the results.

There are a few fundamental principles which should govern all reinforced concrete construction, especially in buildings of considerable height, which have been set forth and insisted upon a number of times in this journal. Among these is an ample provision for the end shear of beams and girders where they connect with columns, and the use of steel reinforcement for the latter in such a way as to be both self-sustaining and capable of acting as a rigid banding or enclosure of the concrete. When these essential principles for good concrete-steel construction were first enunciated, there had been few or no failures to support them so conclusively, but a number have occurred since then, and this conclusive demonstration loses none of its force by being partially of a negative character.

In this class of failures, more particularly in those which have taken place within the last year, there has been much work of investigation in connection with the wrecks and the usual crops of explanations. In scarcely a single instance, however, have the published reports of these investigations disclosed any consideration of these two important features of design. While there are many versions of the explanations given to the public they can usually be reduced to one, the supporting forms or temporary supporting struts were removed while the concrete was too green. The age of such concrete has generally been not less than two to three weeks, and in scarcely any prominent instance has it been placed in really cold weather. Material evidence as to greenness of the concrete is generally or always lacking, although the judgment is rendered with all desirable confidence. As a matter of fact, if good cement is used and the concrete well mixed, both of which requirements are almost always stated to be satisfactorily fulfilled, there should be no danger whatever in removing the supports after the concrete has been set from two to three week in all but our winter months. Indeed, with proper precautions taken by artificial heating, it is scarcely possible that concrete placed in permissible winter weather should not acquire ample strength for the removal of forms or supports at the end of three weeks.

If one will turn to the report of the two experienced engineers who investigated the collapse of the Eastman Kodak Building, as printed in The Engineering Record of Feb. 2, no reference will be found either to any provision for end shears of the beams or girders carried by the failed column or to the nature of the reinforcement of the latter. A similar general observation can be applied to the description of the collapse printed in The Engineering Record of Jan. 5. Apparently the concrete only was designed to carry the end shear of the beam; while information is not definite on this point as respects this building, this use of concrete is a weak feature of a large class of such construction. Small horizontal steel bars extending into the columns from beams are sometimes provided. Although such bars possess no sensible shear-resisting capacity they are sometimes depended upan to relieve the end shear conditions, but even such rods appear to be absent in some cases in the Rochester building. Aside from the presence of the shavings, blocks and other wooden litter which might have initiated the collapse, a shearing failure at the ends of the beams might have produced the same result most effectively.

Placing entire dependence upon the concrete to carry end shear is reprehensible designing, and it should not be practiced in any case where loads of magnitude are to be sustained. Greenness of concrete will have much more prejudicial effect upon the shearing capacity than upon the compressive resistance. Undoubtedly concrete may possess the shearing resistance which many tests indicate, but this cannot be relied upon. Cracks too small to be readily detected may and frequently do form as the concrete sets, destroying so large a part of the end shearing capacity as to endanger its fitness for even light loads. As far as information has been disclosed it is not improbable that this was at least one of the sources of failure at Rochester.

Again, a concrete column reinforced by small longitudinal bars so common at the present time and as appears to have been the case in this instance, whether well banded or not, is a pretty poor kind of reinforced column at best. It may do well enough for light work, but it has some highly unsatisfactory features where heavy loads must be sustained. It is doubtful whether the small steel bars will carry their proper load or not, but if they do their tendency to buckle causes a corresponding tendency to split the column and greatly reduce its bearing capacity. While this tendency may be counteracted to some extent by suitable banding of the columns, the arrangement is unsatisfactory.

The fragments of the columns remaining after the collapse show their failed sections to have been at the floors, precisely where failure by end shear co-operated with direct column weakness to produce the collapse. There is at least as much reason to attribute the wreck to weak details in the features described as to the greenness of the concrete. Suitable column reinforcement and a proper reinforcement of the beams and columns meeting them, all so arranged as to enable the steel to carry end shear, would without doubt have prevented the wreck.

Technical Graduates and Central Stations.

A few weeks ago Prof. George D. Shepardson contributed to the "Electrical World" an article discussing the advantages and disadvantages of work with central stations from the viewpoint of a technical graduate. This is a special feature of the general subject of the opportunities for those young engineers who do not look with any great amount of favor on a career spent over a designer's desk. Up to within a few years, most technical graduates probably looked forward to occupations connected with the improvement of machinery or the design of new structures. It has lately become apparent, however, that not only are the number of positions of this sort rather limited in comparison with the size of the classes at the polytechnic schools, but the opportunities for advancement which such positions afford are not any better, to say the least, than those of places which may not have quite such a technically important name, but are practically just as necessary to the progress of engineering work taken as a whole. The central station offers to young men a variety of occupations which Professor Shepardson considers well worth considering. The apparatus in these plants is so complicated and the necessity of forestalling any interruption of service is so important that the work demands men who can not only understand the directions given for the management of the equipment but can also analyze the reasons for the practice. It requires men who can determine the best methods of handling new apparatus without costly accidents and delays. The often neglected smaller stations in particular need management by such trained men, and when a number of such small plants are brought under a single ownership, there are technical places created which are of considerable responsibility. The objection to all such work, in Prof. Shepardson's opinion, is that the compensation is small in return for the time and money spent in acquiring a technical education.

This subject has been discussed by a number of men prominent in central station work, and their letters to the journal mentioned afford a valuable indication of how far the general requirements of such work can be considered as calling for technical graduates. Mr. W. C. L. Eglin, of the Philadelphia Electric Co., states that he is confident those who enter the service of operating companies and devote their attention to the work will make more rapid progress than those entering the employ of manufacturing companies. Prof. D. C. Jackson writes quite enthusiastically of central station work as a field for the technical graduate, particularly if he combines business ability with engineering knowledge.

Mr. F. W. Frueauff, of the Denver Gas & Electric Co., stated that it is becoming more and more necessary to have trained technical men in close touch with every branch of the central station business. As the cost and selling lines are drawing closer together, it is desirable to have each feature of operation watched by some one thoroughly educated in the work. The technically educated man is able to appreciate and adopt the many small wrinkles which are trifles in themselves, but make collectively an important total. Moreover, a technically educated man can be shifted from one position to another better than a man who has been trained to do but a single thing and has limited engineering knowledge. It is a mistake, in his opinion, for a station to depend on one technical man. In the long run, he believed, the technical man is bound to finish first, as he will have a general knowledge of all branches of the business and be in touch with all parts of it, while with the commercial man his work must necessarily be of a special nature.

These opinions are but a few of those contributed to the journal mentioned by men in a position to speak authoritatively about the subject. They emphasize what The Engineering Record has repeatedly pointed out, that the great field for the graduates of technical colleges is not the designing room, but the operating and construction departments that take up work where the designing engineer lays it down. The reason that this great and promising opening for technical graduates remained unappreciated so long was largely the fault of the colleges, which persisted in turning out designers only, regardless of the fact that a happy combination of technical knowledge and business sagacity will find far greater rewards and achieve work equally useful in other directions than planning machinery or structures. Fortunately this fact is now generally understood, and most of the important engineering schools suggest at one time or another to their undergraduates that there are places full of honor and of profit which technically educated men are especially qualified to hold, although these positions are essentially "business" places and those who take them must become business men and live by the rules of commercial corporations rather than the regulations of the select circle of "professional" men.

The Municipal Engineers of the City of New York.

A couple of years ago attention was called in this journal to an organization of engineers connected with the various municipal works of New York City. It was pointed out at that time that the opportunities for advancing the welfare of the technical staff of the city afforded by such an organization were very great, but that it depended entirely on the members whether the society should be a marked success or a dismal failure. Under the wise direction of its officers, it has been growing in influence and in technical value until at the present day the Municipal Engineers of the City of New York, as it is called, numbers a little over four hundred members and has become a factor of considerable influence. It has recently moved into permanent quarters in the United Engineering Building on Thirty-ninth St., and its future seems a promising one.

The great diversity of the public works of the city call for an engineering staff with duties of the widest range. The bridges owned by the city include not only some of the largest structures ever undertaken, but also a great number of short spans of countless variety. There are suspension bridges, swing bridges, sliding bridges, bascule bridges and a host of girder and truss spans ranging from the lightest to the heaviest types. In the matter of sewerage and sewage disposal few people understand what a complexity of problems, designs and methods is to be found in the several boroughs of the city, while the water supply is drawn from such different sources and is delivered in so many ways that its engineering features embrace practically the whole range of this branch. The pavements are similarly diverse, the park problems are multifarious, and the work done by the engineers connected with the building bureaus varies through the entire range of architectural construction. In addition to these main features of the municipal departments there are many others of a less extensive scope which are handled largely through technical staffs.

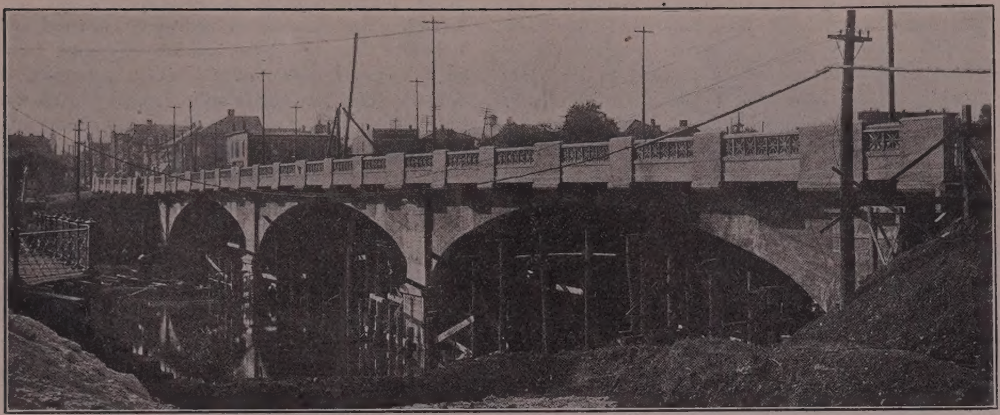
All this extensive and varied engineering work is done for a single interest, the city, and it is therefore very desirable that those connected with it should understand at least the general features of each department and the character of the problems that arise in them. Without some such organization to bring the engineers together it is probable that in the course of time some bitter departmental jealousies might arise on account of misunderstandings that would never occur if the engineers knew each other so well that they talked over their problems as intimate acquaintances rather than as employes of different departments. Without in any way belittling the value of the technical proceedings of the society, it is probably correct to say that its work in bringing together socially the men of different departments is its most useful feature, although the excursions it arranges to important engineering works in the vicinity are also of much importance. Another excellent feature of the society's methods lies in the eligibility to membership in it of men who are not eligible for admission to the American Society of Civil Engineers in grades which they care to join. The society brings together everybody connected with the engineering work of the city and aims to be as helpful to those members in the minor positions as to those whose engineering responsibilities are very great. The success of the organization is proof of its usefulness, and while there are probably few cities large enough to employ a technical staff needing such a society to advance its interests, it is gratifying to observe that in a great municipality an association of the engineering employes can become a useful and influential body.

Notes and Comments.

THE TWO THREE-TRACK TUNNELS that are being driven across Manhattan Island from the East River to the new Pennsylvania terminal have encountered such bad material that the railroad and contractors have asked permission to conduct 1,400 ft. of the work in Thirty-second St. and 900 ft. in Thirty-third St. in open cut. Along these stretches the material to be traversed is of such a nature that the safety of the adjoining buildings requires open trench work, according to Messrs. Charles Sooysmith, Gustav Lindenthal and Howard A. Carson. The cut is to be kept covered, as was done on lower Broadway, and there is to be no interference with traffic on the streets except between 11 p.m. and 7 a.m. It would appear from general experience elsewhere in tunneling through running sand that this request is one that should be granted. The older buildings can be underpinned and supported readily if the open cut is allowed; but if the work must be continued by tunneling, unquestionably serious damage will result from the operations.

THE RENSSELAER POLYTECHNIC INSTITUTE at Troy has at last received a gift which will enable it to develop its work along the lines necessary for a school of its sort to attain the most usefulness. The Institute has always been a civil engineering school, and on this account has felt the competition of other schools able to offer courses in civil, mechanical and electrical engineering. It is pretty generally proved by experience in technical education that schools must give courses in several somewhat related subjects in order that they may prove most attractive to young men. Fortunately for Rensselaer, Mrs. Russell Sage has just given it one million dollars, which is available for the schools in mechanical and electrical engineering so much needed at Troy. Mr. and Mrs .Sage lived in Troy for a considerable time and their nephew, Russell Sage, second, also lived there and was a graduate from the Rensselaer Polytechnic Institute. Accordingly there was every reason why these new courses should be founded by Mrs. Sage, for she can take a personal interest in them which is impossible in the case of institutions elsewhere which have applied to her for assistance.

THE FILTRATION SUITS IN PHILADELPHIA which were brought by the city against Mr. James P. McNichol and others were decided by the judge of the trial court recently in an opinion of great length that is asserted by each party to be a victory for it. Inasmuch as the city has announced its intention of appealing from the decision, however, the victory is probably not so great as it hoped for. According to it, five of the contracts executed by Mr. McNichol and his associates were illegal because he was a city official at the time they were carried out, and the use of his wife's name in legal matters during that period was a mere subterfuge. Accordingly the city is to be paid the difference between the cost of the work as shown by the contractor's books and the sums he received from the city for it. Mr. McNichol says this is entirely satisfactory to him, as he lost money on all these contracts and will be glad to have that fact shown by the expert accountants who make the examination of his books. The judge states that there is no evidence of fraud in procuring and executing the remaining contracts with the city, eleven in number. The judge further says that there is no proof whatever of any collusion between the Department of Public Works or its engineers and the contractors, so that once more Mr. John W. Hill receives a judicial vindication of his work as chief engineer of the Bureau of Filtration. It must be said that the decision is a proof of the usefulness of laws prohibiting anybody in a city government from having any financial connection with the city as a contractor or supply man. It is absolutely necessary for the satisfactory administration of public affairs to make and enforce such laws, and the court's decision that a public office-holder cannot hide his interest behind the protection of his wife's name is a welcome one.



The Reinforced Concrete Bridge over the Tuscarawas River at Canal Dover.

THE FACTORY STREET BRIDGE IN CANAL DOVER, OHIO.

By Edw. Stingel, New Philadelphia, Ohio.

After a service of some thirty years, the bridges which carried Factory St., in Canal Dover, Ohio, across the Tuscarawas River and the Ohio Canal, needed to be replaced. Some time during the year of 1902, both bridges were condemned by the proper authorities, but were allowed to remain until two years later. The bridge over the Ohio Canal was a Howe truss of a clear span of 74 ft. The river was crossed with a three-span Fink truss bridge of a total length of 327 ft. There is only a distance of 60 feet between the river and the canal at this place.

After the usual proceedings of complying with the law, the contract was awarded to Mr. E. J. Landor for a four-span arched reinforced concrete bridge of the Thacher type for the sum of $105,000 in round numbers. Construction was begun June 1, 1905, and the bridge was completed by June 1, 1906.

Each of the three arches over the river has a clear span of 106 ft. 8 in., a rise of 11 ft. 9 in. and is of the three-radii type. However, two small curves were introduced below the springing line to give the arches a more graceful appearance. The radii of the intrados are 149.17, 32.25 and 4 ft., while the radius of the extrados is 203.91 ft. The arch rings have a thickness of 24 in. at the crown, increasing to 5 ft. 6 in. at the skewbacks. The arch rings are reinforced with two sets of 1¼-in. Thacher bars spaced 12 in. on centers; one set is placed 3 in. from the extrados, and the other set is placed 3 in. from the intrados. All bar connections were made by means of turnbuckles.

The canal bridge has a clear span of 70 ft., a rise of 10 ft. 6 in., and the arch ring has a thickness of 15 in. at the crown increasing to 36 in. at the skewbacks. This arch is reinforced with two sets of 1¼ in. bars spaced 18 in. on centers. The radii of the intrados are 74 ft., 18.69 ft. and 4.94 ft., while the radius of the extrados is 84.39 ft.

The piers are 10 ft. thick at the springing line.

The width of the bridge over all is 55 ft., and the clear width is 53 ft., made up of sidewalks of 7 ft. 6 in. and a roadway of 38 ft. The sidewalk slab is 6 in. thick, of cantilever construction and supported by reinforced concrete brackets. The sidewalk slabs are reinforced with ⅝-in. bars spaced 6 in. on centers and the brackets supporting these slabs are reinforced with 1¼-in. bars spaced 6 in. on centers.

The concrete in the arches, spandrel walls and sidewalks is a 1:2:4 mixture and the concrete in the piers and the abutments is a 1:3½:5 mixture. The aggregate is composed of gravel and sand taken from gravel banks near the work; the gravel and sand were separated and later mixed in the proper proportions.

The foundations were built by means of cofferdams, steel sheet piling being driven around the space where the foundations were to be built. After this was done, a steam pump was set to work pumping the water out of the cofferdam but the water could not be lowered, although seasoned strips of wood were placed in the joints of the piling. Wood sheet piling were then driven around, and about 2 ft. from, the steel piling and the space thus formed was filled with earth. This being completed, the same pump which was used before easily pumped the cofferdam dry. The river bottom at this site is composed of gravel to a depth of about 150 ft. There were 147 piles driven for the pier cofferdams, 165 for the river abutment cofferdams and 120 for the canal cofferdams. Rough forms were built for the footers into which the concrete was placed. The forms for the piers and the abutments were then set on these footers and built up to the small curve two feet below the springing line.

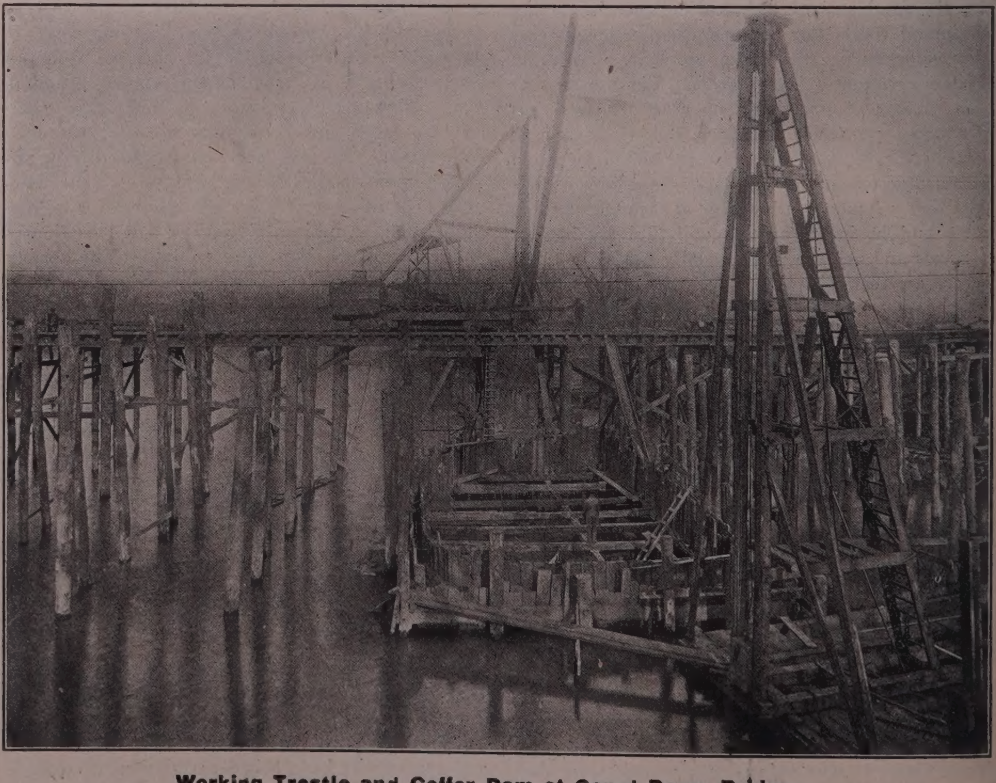
The centering under the river spans was made up of nine bents to each arch, each bent having 7 piles. The canal span centering was built with six bents, each bent having seven piling. The piles were capped with a 3 x 12-in. timber. The wedges were made and placed as shown on the accompanying plans. The curve strips were sawed to the correct curvature and nailed to the 2 x 12-in. joists. The State Canal Commissioner required a clear waterway of 18 ft. through the canal centering. All falsework piling was driven from a scow. One-inch lagging supported by 2 x 4-in. verticals was used. These 2 x 4-in. sticks were spaced 18 in. on centers, and with this spacing were found too light when used to a greater height than 4 ft. It is very important that the falsework be constantly checked; this will be realized when checking after a strong wind.

The foundation piles were driven with a 3-ton steam hammer and all other piles with a 1-ton drop hammer.

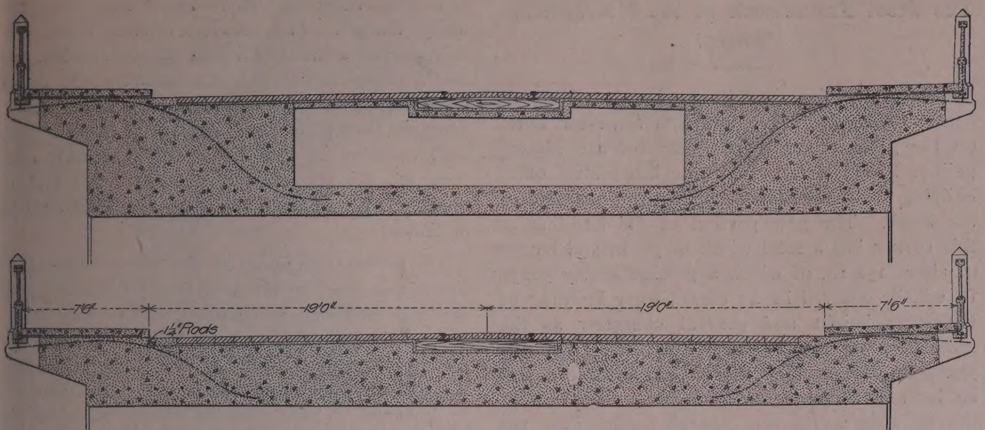
A trestle was built on the upstream side of the bridge, on which were placed two tracks. On the south end of this trestle was located the mixing plant. By means of this trestle and a movable boom derrick all the materials were handled. The following method of concreting was employed in the first span: Sections 1 and 1, see diagram, were built first, then sections 2 and 2 were built, and so on finishing with sections 6 and 6. The numbers on the arch refer to span 1, and those above the arch to spans 2 and 3. The bulkheads *A* were always built first. After this arch was turned, it was found that the 6 x 6-in. struts, marked with an asterisk, were loose, not bearing on the piling by one inch. The next two spans were concreted the following way: Sections 1 and 1 were built first, then sections 2 and 2 and ending with section 6. The centering remained firm and intact under this method of concreting. Only one gang of men was employed concreting on the arches. Each section was begun and finished without interruption.

The wedges under the canal span were driven after the arch had set for a period of five weeks. No difficulty was encountered in driving them. The arch deflected 0.5 in. at the crown and after the spandrel walls were built and the fill made, it deflected an additional 0.4 in., making a total deflection of 0.9 in. This arch was built 1/800 part of the span higher than the plans showed to allow for this deflection.

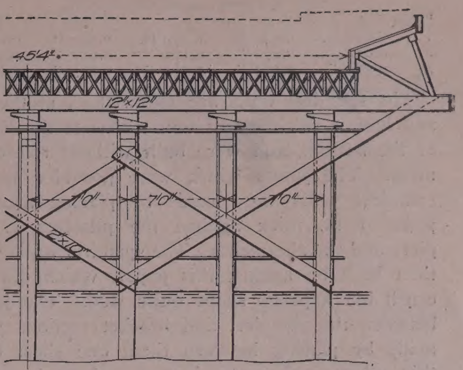
The canal span was begun Nov. 1 and finished



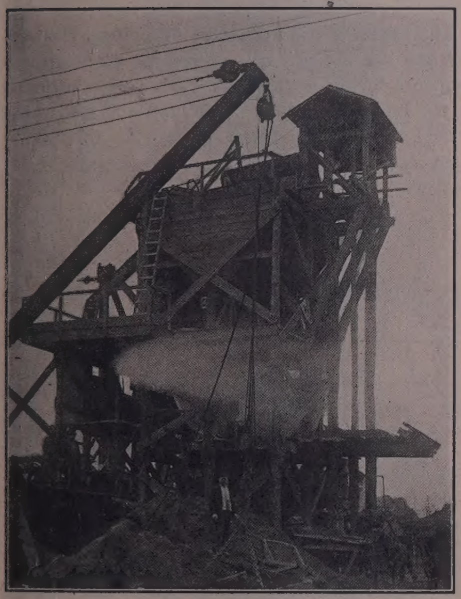
Working Trestle and Coffer Dam at Canal Dover Bridge.



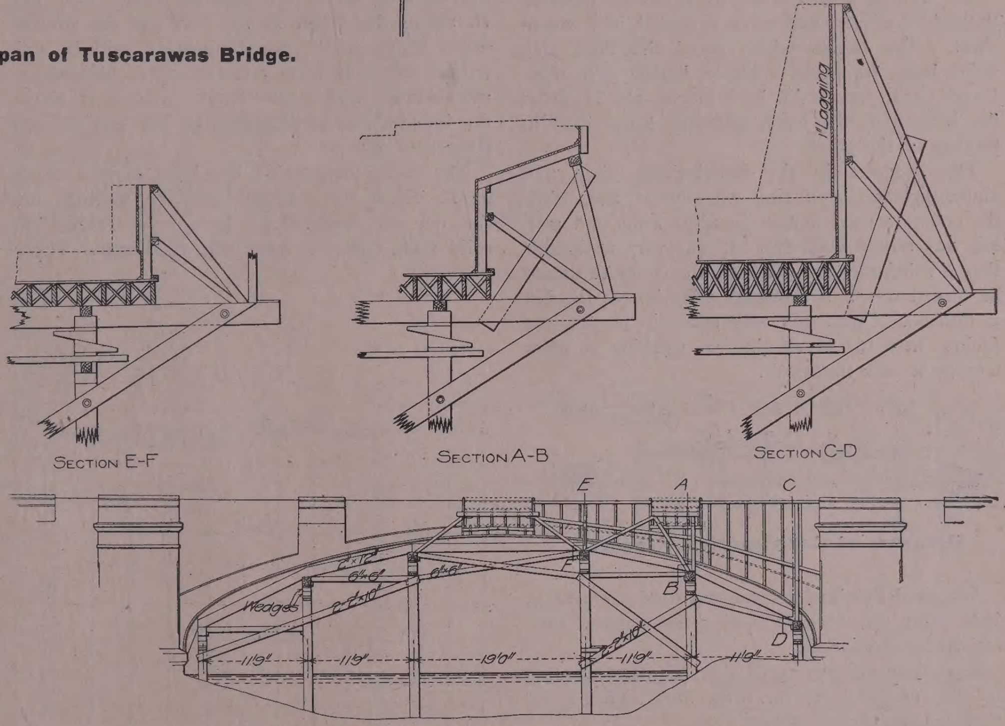
Cross-Sections of Canal Span of Tuscarawas Bridge.



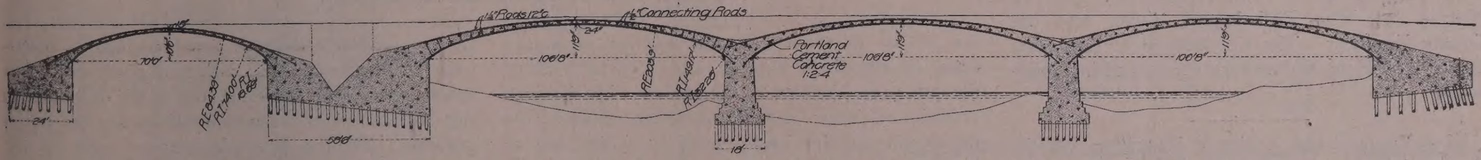
Section, Canal Span Centers.



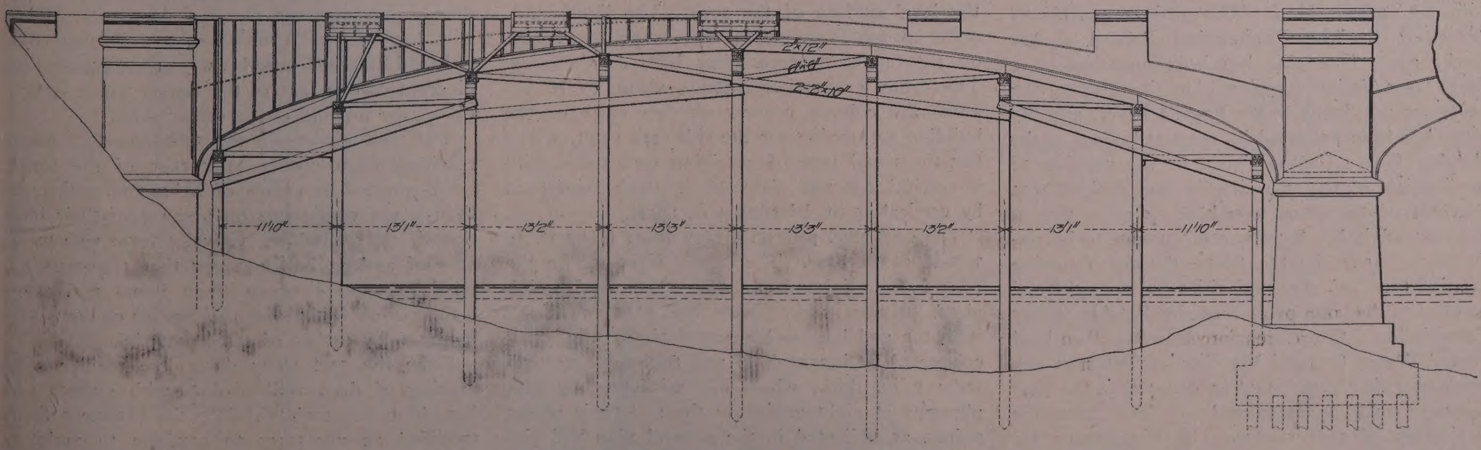
Concrete Mixing Plant.



Centering Used in Construction of Canal Span.



General Elevation of Reinforced Concrete Bridge over the Tuscarawas River and Ohio Canal at Canal Dover.



Falsework and Centering for North Span.

Nov. 12; the first river span was begun Dec. 11 and finished Dec. 22; the second river span was begun Jan. 16 and finished Jan. 22; and the third river span was begun Jan. 25 and finished Jan. 30. These dates are the time of concreting only.

The deflections of the three river spans are given in the accompanying table, the letters indicating points marked on the diagram showing the successive steps in the concreting.

Point *A* deflected 0.015 feet; point *B* deflected 0.040 feet.

DEFLECTIONS OF RIVER SPANS.

Span.	*A*	*B*	*C*	*D*	*E*
1	0.015 ft.	0.040 ft.	0.050 ft.	0.032 ft.	0.040 ft.
2	0.052 "	0.070 "	0.121 "	0.067 "	0.045 "
3	0.082 "	0.102 "	0.112 "	0.085 "	0.045 "

The spandrel walls are 18 in. thick at the top and have a thickness of four-tenths of the height at the bottom, and were built without reinforcement. The joints which were provided in the spandrel walls were made by placing asbestos paper 1 in. thick against the pilasters at the piers and the abutments. The spandrel walls were then built up against this paper, which did not crush but kept its shape quite well. The joints between the spandrel and bracket sections were made by placing between them one sheet of a thin waterproof paper, just enough to keep the walls from joining with the brackets.

The railing blocks were made indoors during the cold weather, and were seasoned in a steam chest. The beams which carry the floor slab were built in place. These beams are reinforced with two ⅞-in. bars placed 1¼ in. from the bottom of the beam and two ½-in. bars in the top of the beam.

The concrete in the foundations, piers and abutments and arch ring was mixed wet, while the concrete used in the spandrel walls and railing was mixed very dry. It was very noticeable that if reinforcement is added, the concrete should be mixed wet if a thorough adhesion to the bar is desired. Great care was taken in placing the facing, with the result that no washing or after treatment was necessary.

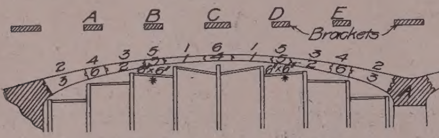


Diagram of Construction Progress.

Diamond Portland cement was used exclusively. Hot water was used in mixing the concrete during freezing weather.

A waterproof coating of a 1:2 mixture was put on the extrados ¼ in. thick and then flushed with a pure cement grout.

A Smith concrete mixer of one cubic yard capacity was used. This bridge was built by Mr. E. J. Landor, of Canton, Ohio. Mr. Paul R. Murray, of New Philadelphia, Ohio, was the County Engineer. The Concrete-Steel Engineering Co., of New York, were the consulting engineers.

THE PROJECT FOR A GREAT RESERVOIR on the Passaic River, either at Little Falls or Mountain View has been advanced somewhat by the action taken on Jan. 24 by officials of the cities of Paterson and Passaic, N. J. This project was briefly described in The Engineering Record a few weeks ago. One plan has been proposed by a State commission appointed to investigate the causes of the floods in the Passaic River, and the other has been proposed by what is known as the Potable Water Commission. At the meeting of the officials of the two cities it was decided that the cost of the work would be so great that it was not advisable for the construction to be undertaken except by the State, thereby throwing the influence of the two cities in an unofficial manner toward the project of the Potable Water Commission. The contract between the East Jersey Water Co. and the City of Paterson expires in a few years, and in order that the new reservoir may be completed not long after the expiration of that contract, it is necessary for the plans for it to be started immediately and for construction to begin as soon as possible. At the present time nothing can be known concerning what will take place until the Legislature acts on the Governor's recommendations concerning the State control potable water supplies.

The Steel Framework of the Metropolitan Tower.

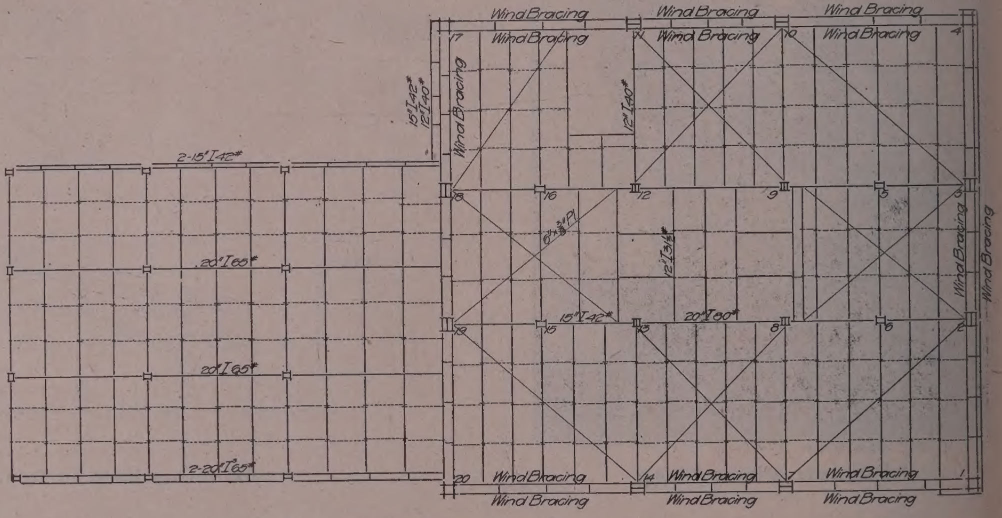
Construction has just been commenced at the corner of Madison Ave. and 24th St., New York, on the great tower to complete for the Metropolitan Life Insurance Co. the large steel office building which already occupies the remainder of the block. The new portion of the building at this corner has a total width of 75 ft. and length of about 152 ft., of which a portion nearly 50x70 ft. will be covered by an eleven-story building of the same height and general character as the remainder of the existing structure. On the 75x85-ft. part at the extreme corner, there will be built a structure uniform with the rest of the building up to the general cornice line, 158 ft. above the street at the level of the twelfth floor, above which the framework will be extended 500 ft. to form a tower 658 ft. high above the sidewalk with a total height of 690½ ft. above the foundations, as described in The Engineering Record of Jan. 12.

The cellar excavation has been carried down 22 ft. below the sidewalk and the footings for the column foundations have been carried to solid rock, some of them 10½ ft. deeper. There are in all 32 main columns and 14 secondary ones, 20 of which support and form a part of the 7,500-ton skelton of the tower, with footings resting on rock and designed to receive the maximum column loads, some of which are as high as 7½ million pounds. The cast steel pedestals of the 20 main columns are seated on grillages of crossed I-beams bedded in concrete on the level surface of the rock. The lighter columns are seated on granite caps or grillage beams on the top of concrete piers built on the rock. The cellar excavation extends about 16 ft. beyond the column centers on two sides of the building to provide for the sidewalk vault, which has the usual type of retaining wall made with a vertical concrete slab 2½ ft. thick reinforced by vertical 15-in. I-beams 4 ft. apart.

The cast steel pedestals vary from 1¼x2 ft. to 7x7 ft. at the base. The largest sizes are for the four corner columns of the tower and weigh about 11 tons each. They are 3 ft. in height, with top and bottom horizontal plates 3 in. thick connected by longitudinal and transverse vertical webs 2 in. thick, which are reinforced by diaphragms at right angles to them at their center points, as indicated in the general plan and elevation. All columns are made in two-story lengths spliced about 2 ft. above the floor levels, and have closed rectangular cross-sections made up of plates and angles. Most of the beam and girder connections conform to standard practice and are made with web-connection angles and reinforced horizontal shelf angles supporting the lower flanges. The heaviest interior tower column carries a maximum load of 3,095,000 lbs. and has a cross-section of 221.4 sq. in. made up of four 6x4x⅞-in. angles, four 4x4x13/16-in. angles, four 28x1-in. plates and six 9x1-in. plates. The wall columns in the tower are of special construction for the extremely heavy loads and to receive the connections of the wind-bracing diagonals.

The corner columns of the tower extend in continuous lines to the 35th floor; but spacing of the side columns is changed at the 29th floor, and at the 31st floor where four of the interior columns end, a system of heavy plate girders support a set of twelve columns offset about 7 ft. inwards. These columns in the walls of the reduced tower extend to the 39th floor, where the pyramidal roof construction commences. Here they are replaced by inclined rafters, while the four central columns are continued until they meet the rafters at the 44th floor.

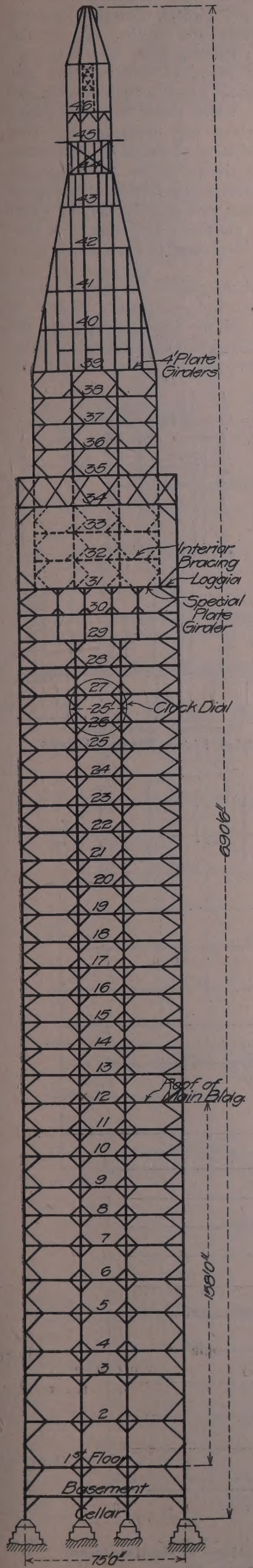
The assumed wind pressure of 30 lb. per square foot on the entire exposed surface of the tower produces heavy stresses which become enormous in the lower part of the structure, and are transmitted through the tower framework directly to the foundations without any attempt to distribute them through the adjacent portions of the lower part of he building, the mass of which is not considered in the computations for the tower stability. In the pyramidal upper part of the tower, the wind stresses are transmitted through the inclined rafters and the diagonal members down to the level of the 39th story, below which they are transmitted through deep wall girders with long vertical connections and through solid web and detached knee-braces, as indicated in the diagram of one face of the tower, which is typical of the bracing on the other sides.



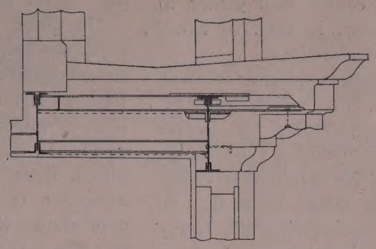
Beam Plan of Tower and Extension.

The wall girders in the 34th and 35th floors, reaching from corner to corner of the tower, are connected by panels of X-bracing, which, although not continuous on account of their location to clear windows, virtually form web members of a deep lattice girder that transmits the wind pressure between these floors and spans a three-story logia screen of marble columns surmounted by arches of same material.

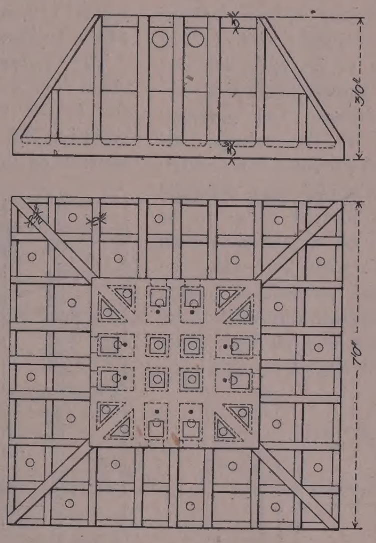
From the 31st story down, the regular wind bracing of deep wall girders with gussets and knee-braces is maintained to the basement floor, modified as necessary to conform to architectural requirements. The principal modifications are the variations between solid-web and detached kneebraces, and in their dimensions and in those of the girders. The X-braces between the 34th and 35th floor girders are pairs of 15-in. channels, one set being continuous and the other cut to



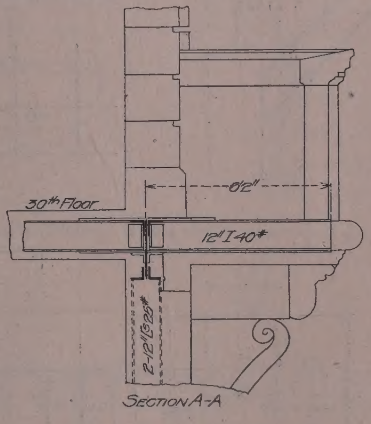
Elevation of Tower.



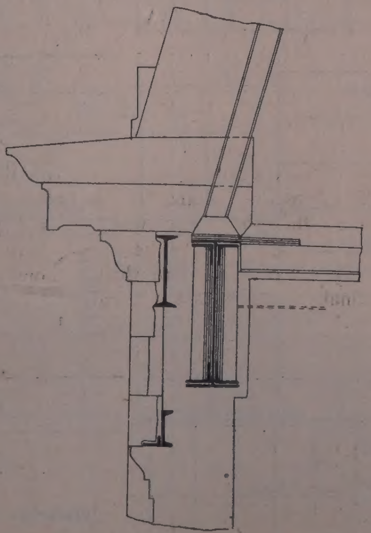
Section at 35th Floor.



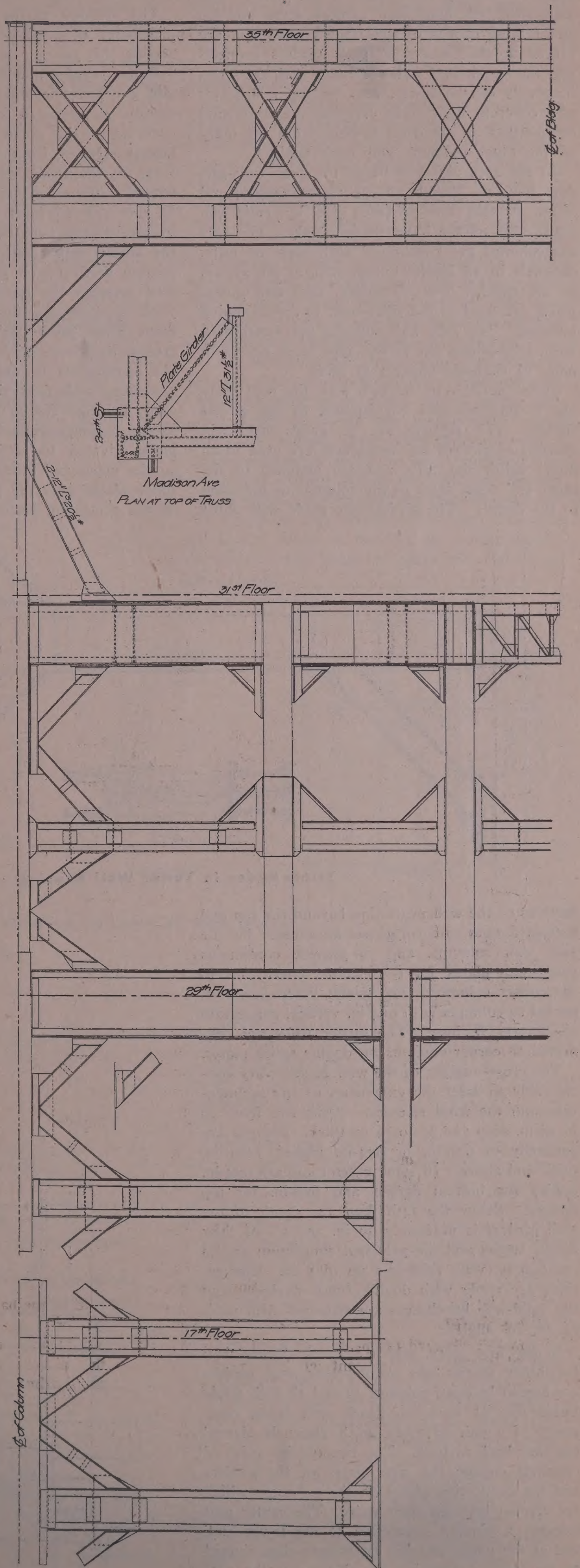
Pedestal for Column.



Section at 30th Floor.



Column Footing, 39th Floor.

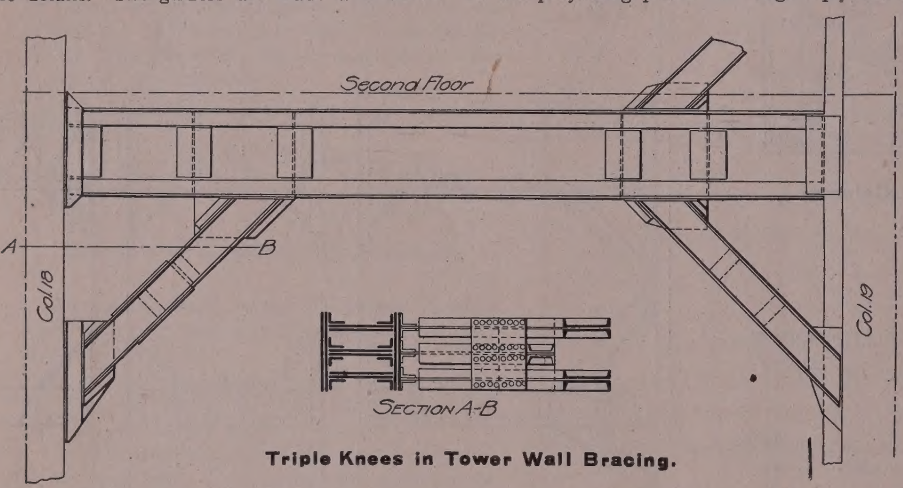


Typical Wall Braces, Upper Part of Tower.

clear at intersections, where all are shop-riveted to very large web connection plates with mitered angles connecting the flanges to the plates. The 34th and 35th floor wall girders form the top and bottom chords of the large trusses and are braced at the corners by plate girders connecting the inner and outer columns on the main diagonals of the tower, also by the floorbeams and concrete floor slabs carrying the horizontal components of the wind stresses from the inner to the outer columns and back again.

At the 29th and 31st floors the deep wall girders have no braces on the upper flanges, and wind stresses are provided for by solid-web kneebraces on the lower flanges only. The corner columns are kneebraced with pairs of 12-in. channels in all stories except that in the second to the twelfth floors inclusive, solid-web gusset plates are used in the sides next to the adjoining building. The side wall columns are kneebraced with solid plates up to the 12th floor and with pairs of channels above that level.

From the 28th to the 14th floor the wall bracing is uniform and corresponds to the panels shown. The stresses are so great that twin systems of girders and kneebraces are used in all floors below the 12th, and are attached to the inner and outer faces of the columns as indicated in the details. The girders are made with short sections of the web projecting beyond the top and bottom flanges to form gusset kneebraces for the side wall columns, and to provide continuous connection plates for the channel kneebraces to the corner columns. The gusset braces are connected to columns with 6x4-in. vertical connection angles 7½ ft. long. The girder webs are connected to corner columns by double splice plates.



Triple Knees in Tower Wall Bracing.

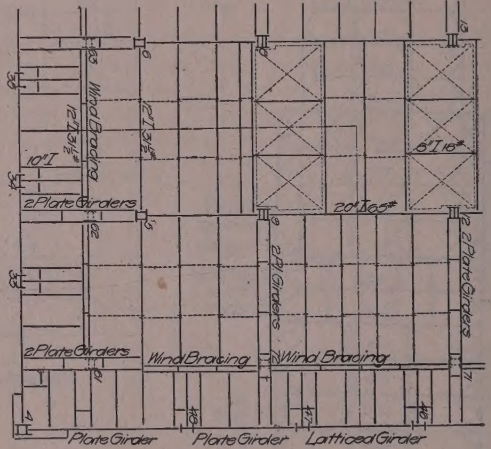
The cross-sections of the wall girders vary considerably to meet the exigencies of the architecture and the wind stresses. Webs run from 20 to 48 in. deep and ½ to ⅞ in. thick. Flanges are generally of 6x6-in. or 6x4-in. angles, 7/16 in. thick and above. In some cases there are 6x4-in. angles for bottom flanges and 6x6-in. for top flanges. Below the 14th floor the depth of the wall girders is uniformly 30 in. and all of their flange angles and the principal connection angles are 6x6 in. with thickness up to 1 in. Connections are made with double rows of rivets, and the solid-web kneebraces are stiffened with pairs of 3x3-in. angles.

In the first story, which is much deeper than the other stories, the second-floor wall girders are braced between columns 17 and 18 with triple kneebraces at each end, each unit being composed of a pair of 12-in. 40-lb. channels riveted together back to back. The two outside pairs of channels engage the web plates of the girders and the connection plates on the columns, which are riveted between their webs. The center unit engages a similar connection at the lower end, and at the upper end has its flanges shop-riveted to tie plates connecting the flanges of the outside units, there being no center wall girder to receive it. This arrangement is used to avoid excessively large column connections.

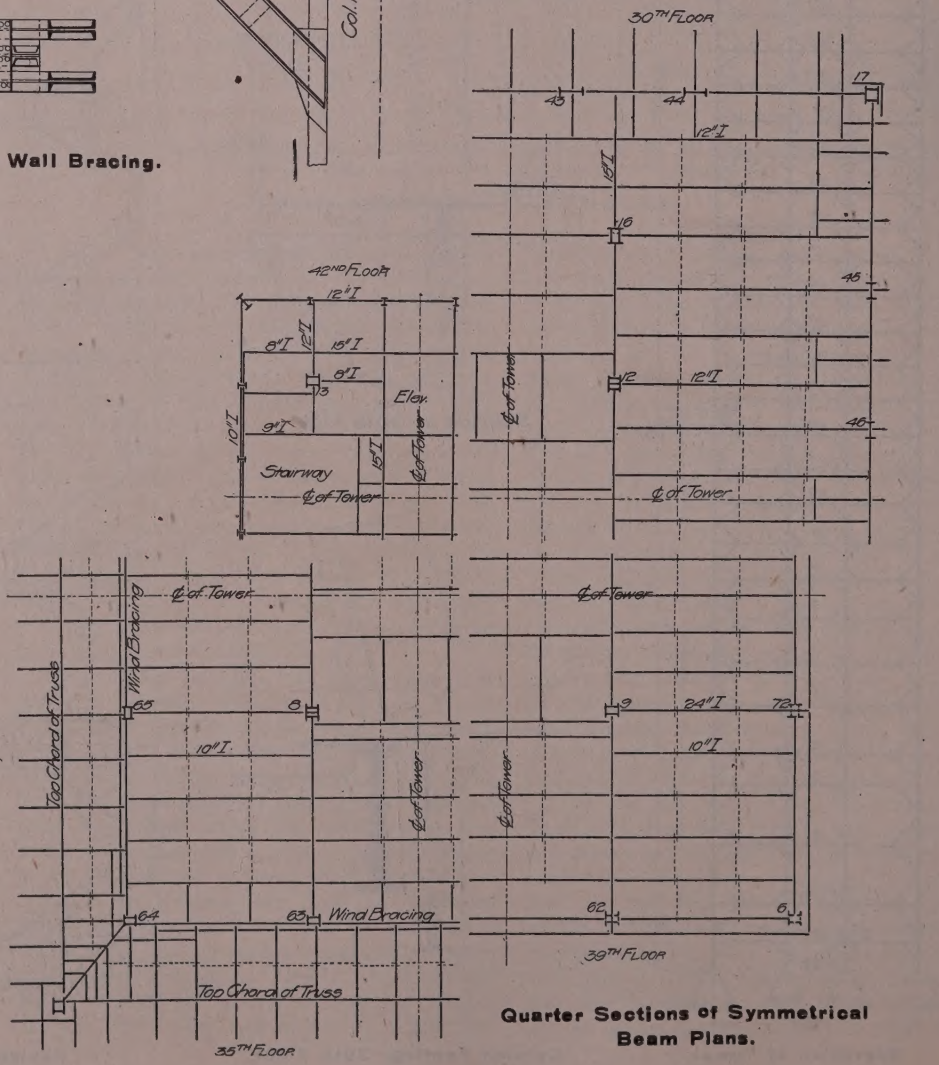
The stresses in the corner columns reach a maximum of 7,500,000 lb., for which a cross-section of 540 sq. in. is provided by twelve 8x8x1-in. angles and three thicknesses of flange and web plates to build up the rectangular cross-section, as indicated in the detail drawing. In order to provide connections receiving the heavy lateral stresses from the wind bracing in both faces of the tower, the main flange plates are extended 6 in. beyond the edges of the angles on one side to form pairs of continuous webs to receive the field connections at one face of the tower, while on the adjacent side of the column vertical web plates 12 in. wide are riveted between the outside angles projecting beyond them for the same purpose. This arrangement gives great rigidity to the column, increases its cross-section, and provides for accessible connections to the horizontal and diagonal members, with field rivets located so as to be easily driven. The columns are spliced, as shown in the accompanying detail, with horizontal cap plates riveted to horizontal connection angles on the upper and lower sections, and with ½-in. splice plates over the flanges and on both sides of the projecting plates and angles provided for the lateral connections.

The floor plans are very simple, and, except as to the special wall girders, conform in general to standard practice and details. Up to the roof of the main building there is a very regular arrangement of 10 to 20-in. I-beams and girders in rectangular panels, as indicated in the fourth floor plan, which shows the eleven-story extension on the east side of the tower. This plan shows the location of the 6x⅜-in. horizontal diagonal bars riveted to the top flanges of the beams and girders and forming triangles to connect the columns and provide against lateral distortion during erection. This system of horizontal bracing is duplicated in every fourth story of the building.

The framing of the 14th to the 28th floors inclusive is uniform and corresponds to that in the fourth floor of the tower, except for the omission of the horizontal diagonals in three-fourths of the tiers and for the variation in the



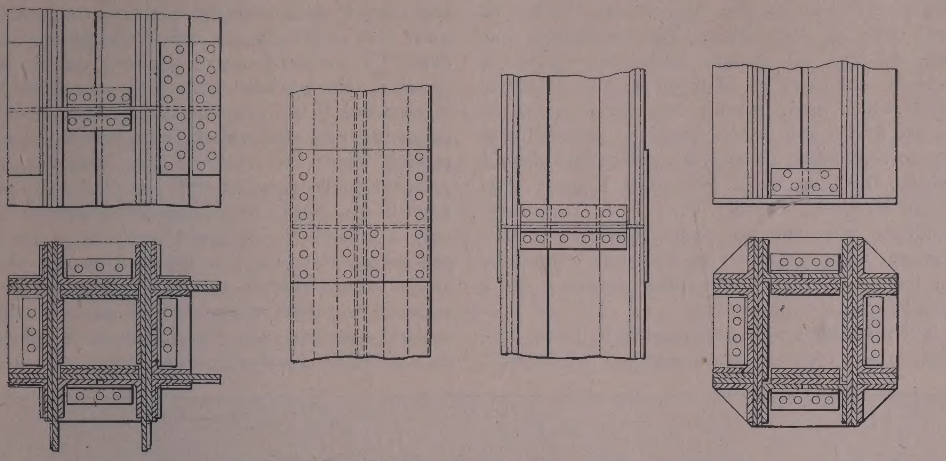
Part Plan of 31st Floor Plate Girders.



Quarter Sections of Symmetrical Beam Plans.

wall girders. At the 30th floor the main framing is the same as below; but there is, in addition, a series of cantilevers projecting 6 ft. 2 in. beyond the single wall girders to carry the loggia balcony and cornice. These cantilevers are made, as indicated by the corner diagram and elevation, with single 12-in. 20-lb. I-beams web connected to the wall girders and spliced across their top flanges and through their webs with 12x⅜-in. flange plates, field-riveted to the cantilevers and to the regular interior beams where the plates of both coincide. The intermediate cantilevers are anchored to short lengths of 12-in. I-beams riveted to the wall girders at one end, and at the opposite end are web-connected to short beams transverse to the wall girders which engage the adjacent floorbeams. When the latter are at right angles to the wall girders on the adjacent sides of the building where the floor beams are parallel to the floor girders, the anchor ends of the cantilevers are web-connected directly to them.

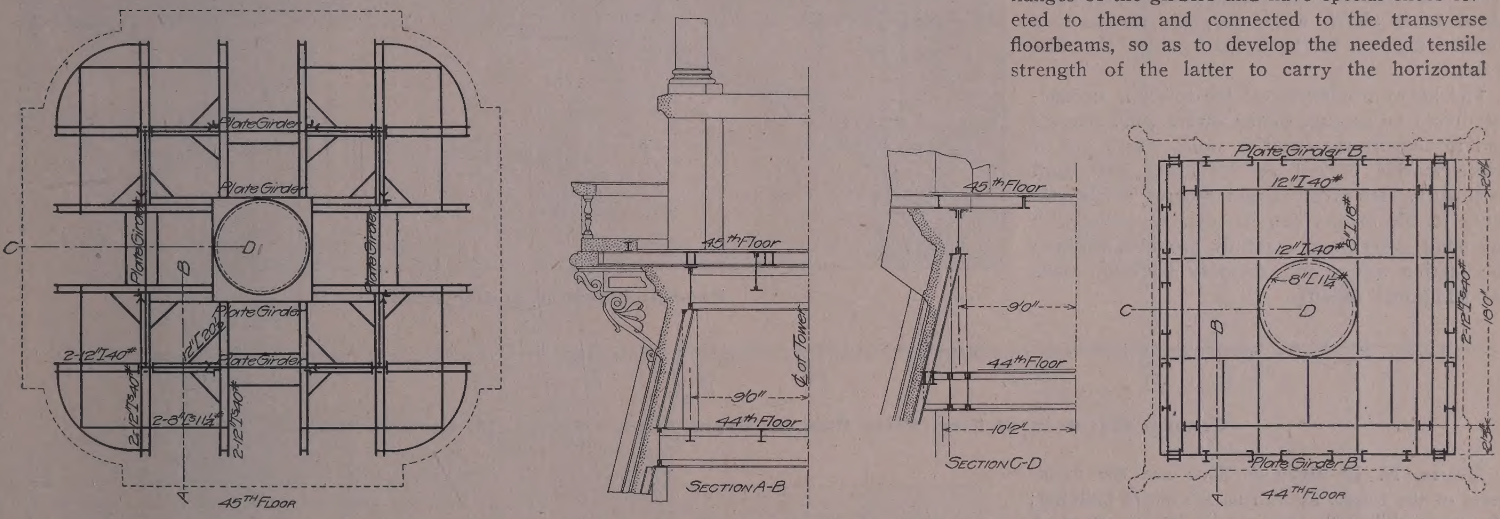
In the 31st floor there is a special arrangement of plate girders connecting the exterior and interior columns so as to provide seats for a new tier of wall columns offset 6 ft. inside the exterior columns to correspond to the reduced dimensions of the upper part of the tower. The arrangement of the single and double girders is shown in the 31st story plan, where the upper story columns are indicated by dotted lines. The girders have a uniform depth of 48 in. and the webs are in most cases ⅞ in. thick. The flanges are made with pairs of 6x6-in. angles, ½ to 15/16 in. thick, with pairs of 14x¾ or ⅞-in. cover plates, except in one case where 8x8x⅞-in. angles and 18x¾-in. cover plates are used. In four cases the girder webs are increased by pairs of 46x⅜-in. full depth reinforcing plates riveted over the vertical legs of the flange angles.



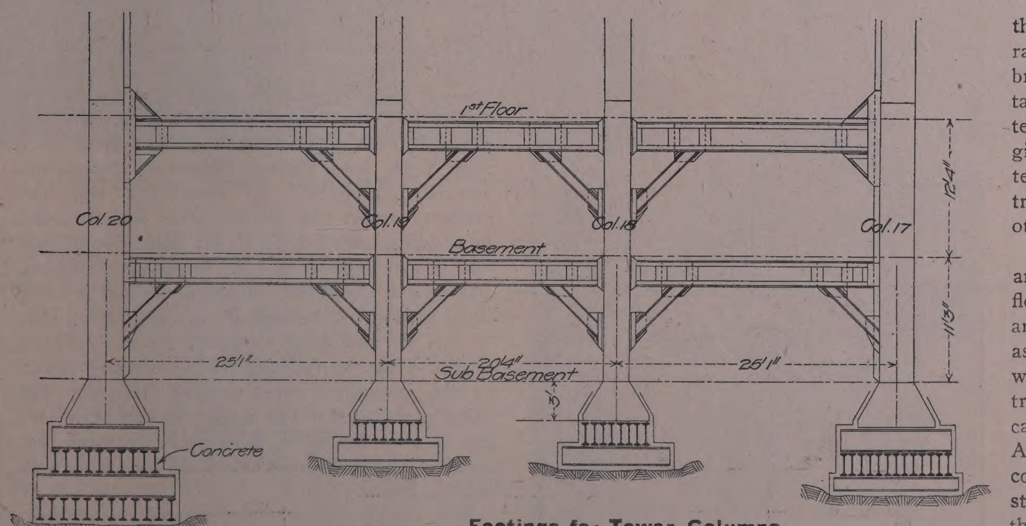
Corner Columns with Double Windbrace Connections.

At the 35th floor the outside corner columns terminate, and the floor between them and the inside wall columns is carried by 8-in. I-beams supported at the inner ends by the wind bracing wall girders and at the outer ends by the top chords of the trusses connecting the corner columns in the 34th story, as previously described. These beams are extended about 3 ft. beyond the trusses by pairs of cantilever angles spliced across the top chords as indicated in the accompanying detail. The framing of the 34th floor is similar to that of the 35th floor, except that the cantilever cornice brackets are omitted.

The vertical exterior columns terminate at the 35th floor, where their upper ends are connected by plate girders 4 ft. deep, made with pairs of 6x6-in. flange angles and 14-in. cover plates, and having 24-in. 80-lb. I-beams riveted outside of them to carry the heavy cornice. The feet of the inclined rafters are seated on the top flanges of the girders and have special shoes riveted to them and connected to the transverse floorbeams, so as to develop the needed tensile strength of the latter to carry the horizontal thrust of the rafters. Where the feet of the rafters are seated on the girders, at points not braced with beams normal to them, the horizontal reactions are provided for by oblique 6x½-in. tension bars riveted to the top flanges of the girders and extending to panel points in the interior of the floor, where the stresses can be transmitted to girders at right angles to each other.



Beam Plans, Showing Kneebraces, and Inclined Columns at 44th Story.



Footings for Tower Columns.

Above the 39th story the area of the tower and its lateral dimensions diminish at every floor, and special arrangements of the floorbeams and girders are provided in these successive tiers, as indicated by a quarter plan of the 42nd floor, which is symmetrical about its longitudinal and transverse center lines, except for slight modifications required by the stairway well on one side. At the 44th floor the width of the tower between column centers is diminished to 21 ft., and the stairway is carried through a circular opening in the center of the tower. The framing at this level is made with wall girders having web plates 36 in. deep and pairs of 6x6x½-in. flange angles, which are seated on the tops of the corner columns and support the longitudinal and transverse 10-in. I-beams carrying the floor. The short vertical columns are carried by the interior beams and girders, 2 ft. 3 in. inside of the corner columns in the lower stories, and support four wall girders for the 45th floor, each of which is made with a 42x⅝-in. web plate and four 8x8x⅞-in. angles and supports two transverse

36-in. plate girders, each about 4 ft. from the center line. The plate girders carry a system of 12-in. I-beams supported on their top flanges, which are anchored to the intermediate girders and project beyond the outside girders to form cantilevers for the upper balcony, and these girders are all braced transversely with diagonal 12-in. channels, knee-bracing them to the wall girders and providing a rigid system of laterals for this tier.

Above the 45th floor there are two more horizontal tiers of beams, one at the base of the marble columns supported on eight struts formed of pairs of 6x6x½-in. angles, and the other about 23 ft. above it at the top of the columns and supported by them, the two tiers being connected through the marble columns by ⅞-in. anchor rods. Each tier is octagonal and is made with longitudinal and transverse intermediate beams enclosing the circular stair well which terminates at the lower tier. They are connected by four vertical struts, each made with a single 6x6x⅜-in. angle forming the corner of a rectangular tower, each face of which is X-braced in two panels by ¾-in. diagonal rods and 3x3-in. horizontal struts. Above the upper tier the steel construction is terminated by a pyramidal framework of eight pairs of 3x3x5/16-in. angles converging from the vertices of the octagon to a center point about 15 ft. above, where they are riveted to a 4x3-in. ring at a height of 650 ft. above the sidewalk.

The heavy framework of the tower is necessitated both on account of the severe wind stresses and to support the exterior walls, which are of white marble backed in the lower part with brickwork. Its great weight secures ample stability to the tower; and its massive walls, with the bond everywhere carefully provided between the marble ashlar and masonry backing, make for additional rigidity.

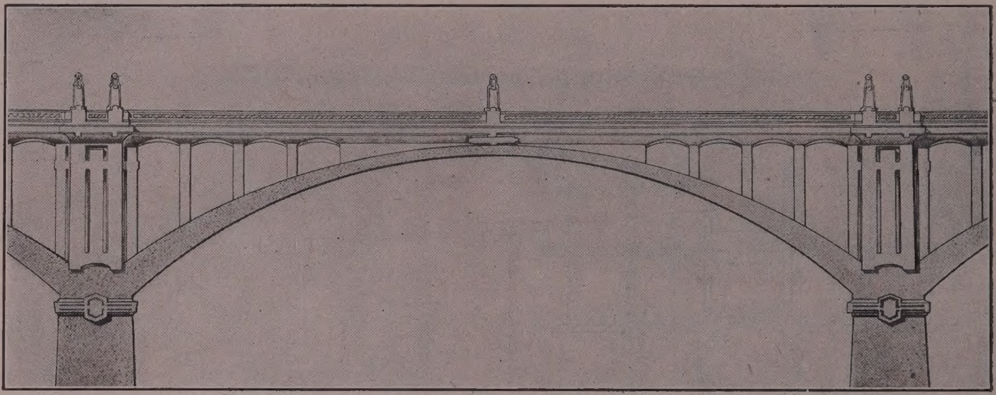
Messrs. N. Le Brun & Sons are the architects of the tower, as well as the entire building; the steel frame was designed by Messrs. Purdy & Henderson, consulting engineers.

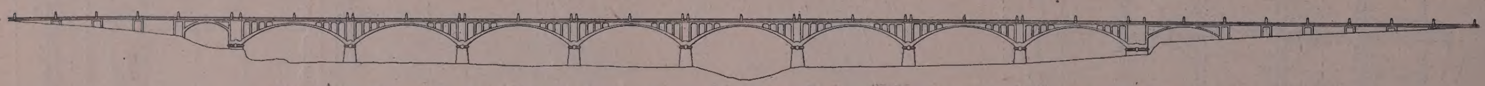
An Unusually Poor Contract was made public in a recent decision of the New York Supreme Court, Appellate Division, in a suit by Westinghouse, Church, Kerr & Co. against the Remington Salt Co. for a mechanical stoker installed by the former in the power station of the latter at Ithaca. The contract contained the following clause: "We guarantee these stokers to burn bituminous coal without smoke when operated according to directions; and to be capable of burning sufficient good rice anthracite coal to develop the full rated horse-power of the boiler, provided each stoker is supplied with a draft represented by the difference in water pressure of ¾ in. above and below the fire. By rice anthracite coal is meant that which will pass through a ⅜-in. mesh and over a 3/16-in. mesh." After the stoker was installed, both parties discovered that the coal sold in Ithaca as rice anthracite is what passed a ⅛-in. mesh and was held on a 11/32-in. mesh. The stokers did not work satisfactorily with the latter fuel, and as a stoker unfit for local coal was not at all what was expected, the salt company endeavored to have the contract recast so as to compel the contractors to install apparatus that would work with what was sold locally as rice anthracite. This the court has refused to approve, as a reformation could not be effected without imposing on the manufacturers a much greater liability than if the salt company had promptly asked for redress.

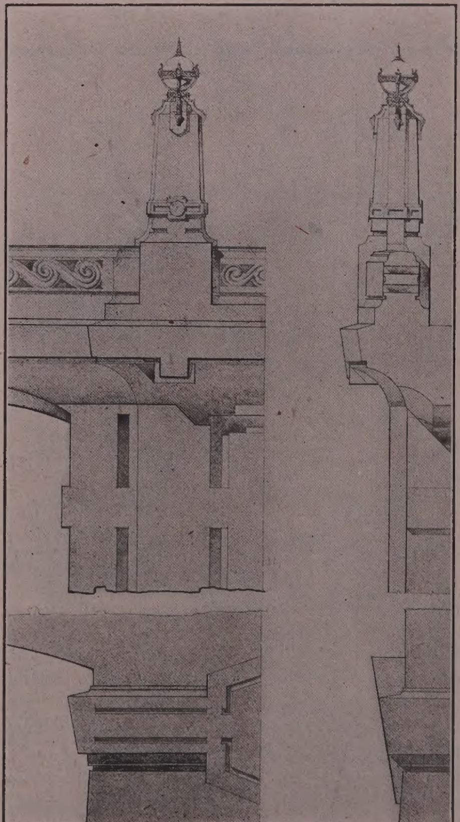
The First Prize Design for the Grand Ave. Viaduct, Milwaukee.

On Aug. 10, 1906, the county clerk of Milwaukee County, Wis., invited competitive designs for a concrete highway viaduct to carry Grand Ave. across the Menomonee Valley in the city of Milwaukee. The invitation announced that all designs submitted would be publicly exhibited in Milwaukee for six days, after which first, second and third prizes of $1,500, $1,000 and $1,000 would be awarded and the corresponding plans and specifications should become the property of Milwaukee County. Mr. Ralph Modjeski, Chicago, Prof. F. E. Turneaure, Madison, Wis., and Mr. Gustav Steinhagen, Milwaukee, were appointed by the joint committee on highways, bridges, laws and legislation as a board to award the prizes.

The invitations were accompanied by plans, profiles, cross sections and photographs of the site, and it was required that the structure, 2,084 ft. long, 60 ft. wide and about 80 ft. in maximum height, should be built of concrete or of reinforced concrete, steel structures being excluded from competition. The total cost of the substructure and superstructure was limited to $400,000 and it was to be built on a right-of-way 100 ft. wide, providing for a driveway 30 ft. wide and 1,000 ft. long adjacent to the viaduct on the south side at the east end. A 40-ft. roadway and two 10-ft. sidewalks were required, and it was specified that no piers should be placed in the Menomonee River, and that certain clearances be maintained for the streets and railroad tracks passing under the viaduct. The structure was specified to be proportioned for dead load plus 1,000 lb. per linear foot for future additions and have a uniformly distributed live load of 100 lb. per square foot plus a 24-ton load on two axles and a 50-ton electric car. The designers were required to submit complete descriptions of their designs together with specifications, a general plan and side elevation, cross-sections, transverse sections, details, strain sheets and diagrams. Isometric, perspective and water-color drawings were excluded, and important and typical details were required to a one-half scale.


General Elevation of One Arch.


General Elevation of First Prize Plan for Grand Avenue Bridge, Milwaukee, Wis.


Details at a Pier.

The competition was closed Oct. 15, with twelve designs submitted, and on Jan. 8, in accordance with both the majority and minority reports of the committee, the first prize was awarded to the design marked M. V. M., prepared by the Concrete-Steel Engineering Co., New York, with Messrs. Palmer & Hornbostel, associated architects. In accordance with the majority report the second prize was awarded to a design marked T. K. C., Minneapolis, and the design signed A. N. Ingenieur, Trenton, was given honorable mention, instead of the third cash prize, because it was considered that it did not sufficiently conform to the requirements of the competition. The minority report of the committee recommended that the first prize be awarded to the design marked M. V. M., and that no second or third prizes be given, because all other designs complied too little with the conditions.

The designs varied from the requirements principally in the length of the structure, which in some cases was reduced beyond the requirements, in excessive total cost, and in failing to provide the required alignment. They included arches built with Considère ribs; concrete arches without reinforcement; three-hinged concrete arches; and spans of from 50 to 300 ft. One design was for a handsome Gothic structure to cost $528,000, and another was of a very elaborate nature called "the Base-ball viaduct," on account of the decoration of the piers with athletic statues representing baseball players, football players and the like.

The right of way originally consisted of two parallel successive rectangles of 500 x 80 ft. and 1,600 x 100 ft., with their center lines 17 ft. apart. This arrangement involved great difficulties in the alignment of the viaduct to conform with the right of way and still provide for the parallel driveway. A single tangent could not have been used without causing the structure to encroach at least 15 ft. on the driveway. The solution finally adopted was to make the axis of the viaduct with two parallel tangents 27 ft. apart on centers connected by a long reversed curve with a radius of about 1,500 ft.

The viaduct crosses from Milwaukee to Wawatoosa over the river and a number of streets and railroad tracks, and passes through a district thickly built up with small, cheap dwelling houses. It is designed to form a part of a handsome boulevard which will be conspicuous from up and down the valley and from an adjacent steel viaduct. The design adopted comprised eight segmental clear spans of 143 ft., one 60-ft. and one 100-ft. approach span and a solid embankment between retaining walls. Between the two tangents, the center lines of the spans are chords of the curved axis, the spans themselves being made square and each occupying a rectangle 66 ft. wide and 157 ft. long over all. The ends of these rectangles for adjacent spans being in contact at one corner and being separated slightly at the other, the difference being provided for in the thickness of the pier which is 7 in. greater at one end than at the opposite end.

The arches are designed on the regular Melan system, 26 in. deep at the crown and 6 ft. deep radially at the skewbacks, reinforced by riveted arch trusses 3 ft. apart on centers. The spandrels are hollow, except for 30 ft. on each side of the crown and the transverse walls shown in the elevation; they are buttressed at intervals, are reinforced to prevent cracking, and carry a standard reinforced concrete floor slab provided with four transverse expansion joints in each span. It is covered with an earth cushion having a minimum thickness of 16 in. and paved with brick or wooden blocks. Each pier, 14 ft. thick, is lightened above the continuous footing by two full-centered arch openings 15 ft. wide and 30 ft. high. The 9x33x65-ft. footings are proportioned for a maximum pressure of about 10,000 lb. per square foot on gravel at a depth of 10 ft. below the surface. The concrete in the arch ring is proportioned for a compression of 500 lb. per square inch, and the reinforcement is sufficient to take the entire bending moment under a stress of not over 18,000 lb. per square inch. The total quantities involved are estimated at 39,000 cu. yd. of concrete, 650 tons of riveted steel and 250 tons of Thacher reinforcement bars.

Special care was taken to make the design simple and effective, and no ornamental work is shown except in the projecting belt courses at the tops of the piers and deep bracket panels above them carrying the cornice and pairs of ornamental lamp posts between the spans. A small panel and intermediate lamp post are provided at the center of each span, and the projecting balustrade seated on a simple heavy molding is made of massive concrete sections cast in molds with a scroll design worked out with open spaces extending through the balustrade, as indicated in the detail. The lamp posts are of solid concrete provided with ornamental metal caps and finials.

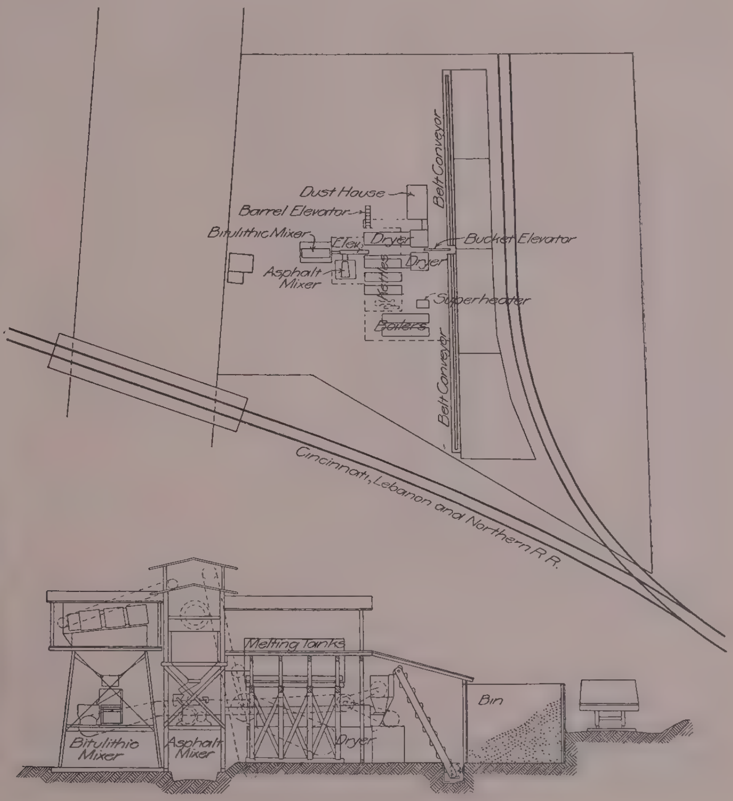
The plans are now being modified in accordance with changes in the approaches and to straighten the axis, as is permitted by a recent action of the property holders in giving the county an additional strip of land to rectify the right of way and thus eliminate the curved alignment. It is probable bids will be invited for the structure about Mar. 1, by the joint committee of bridges and highways and board of supervisors of Milwaukee County and city, Mr. Gustav Steinhagen, consulting and supervising engineer.

The Channel Tunnel Project between France and England is being strongly opposed in British military circles.

The Design and Construction of Two Asphalt Mixing Plants.

The various degrees of success that are secured in laying asphalt pavements can be largely attributed to differences in the apparatus and methods employed in the preparation and mixture of the materials. The arrangement of mixing plants and the methods employed in their operation is in a general way much the same, the chief cause of the varying results obtained in using their products being due to differences in the details of design and operation. Two mixing plants involving a number of good features were recently described by Mr. Chas. Brossmann, Jr., in a paper presented before the Indiana Engineering Society, and from that paper the following notes have been taken. One of these plants is in Cincinnati and is owned and operated by Mr. Wm. Scully, an asphalt pavement contractor; the other is a municipal repair plant in Pittsburg. Although mixtures are very important, as is also the regulation of temperatures in heating, neither of these features were discussed at any length, the paper being devoted to the description of the design and construction of the two plants, which were both built with the method of heating and the regulation of temperatures as primary considerations.

View Looking Toward Sand Heater, Pittsburg Plant.



Asphalt Plant in Cincinnati.

The Cincinnati plant has a capacity of providing materials for 2,000 sq. yd. of pavement a day and is built to handle materials for both bitulithic and asphalt pavements. The general arrangement of this plant is shown in one of the accompanying illustrations. It is built along a switch track which is at sufficient elevation so that sand and stone may readily be unloaded from cars on the track into bins along the latter. These bins have a capacity of 1,000 cu. yd. and are separated into four compartments for sand and stone. A belt conveyor is extended along the inner and lower side of the bins from each end of the latter to their transverse center line, the conveyors delivering to a bucket elevator at that point. This elevator discharges into small elevated bins from which the sand and stone driers are supplied. The driers are of the Cummer type with a combined capacity of 12 tons an hour. They are heated and the materials are maintained at the proper temperatures by superheated steam. The driers discharge into an elevator which raises the materials into a hopper above the asphalt mixer, the sand and stone being drawn into the latter as required.

The asphalt melting tanks, which have a capacity of 25 tons, are placed on a floor over the driers and are equipped for mechanical and air agitation. The material is heated by superheated steam in a jacket around each melting tank. The superheated steam is supplied by a special superheater in which the temperature may be regulated to the required degree. This superheater is arranged to take steam at 10-lb. pressure, which has a temperature of about 240° Fahr., and raise it to the degree necessary for the different asphalts, which is generally in the neighborhood of 350° Fahr. The superheater also supplies steam for heating the sand and stone in the bins above the mixer.

The asphalt mixer is mounted on an elevated platform so that its charging buckets can be fed directly from the elevated stone and sand bins and from the asphalt melting tanks. The mixer discharges into wagons on a roadway under the platform on which it stands.

A regular Warren outfit for mixing bitulithic is installed in connection with the plant. This outfit is similar to the one that was described some time ago in this journal, consisting of an elevated multiple screen, with a multiple bin under it and a mixer under the bin, the whole immediately adjoining the asphalt mixing structure. The stone or sand when raised from the driers by the elevators can be diverted from the latter either into the elevated bins of the asphalt plant, or into the screen of the bitulithic plant. The piping from the melting kettles is arranged to supply material from the latter to either mixer.

The power to operate this plant is supplied by two locomotive type boilers, with a combined capacity of 100 h.-p., which are operated at 100 lb. pressure. The mechanical equipment is driven by a 12 x 16-in. Lane & Bodley engine running at 150 r. p. m. The ordinary attachments of a complete small power plant, such as a feed water heater and boiler feed pumps, are included, auxiliary injectors for the boilers also being provided.

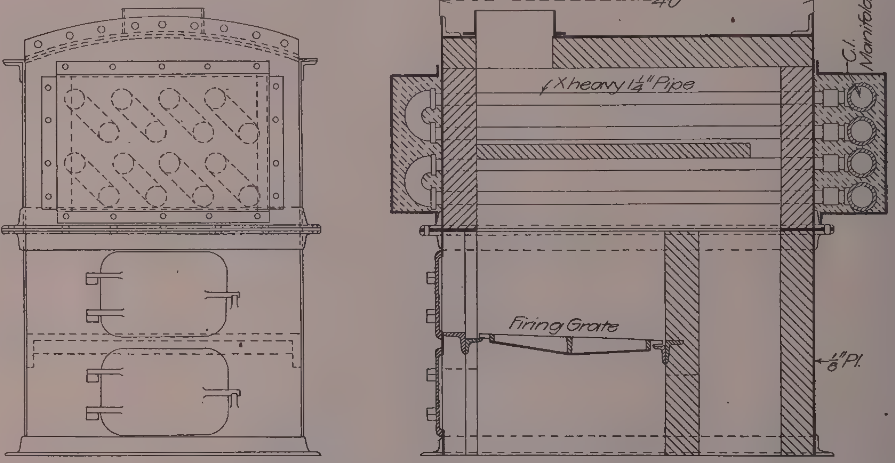
The plans for the plant were prepared by Messrs. Brossmann & King, of Indianapolis, Ind., and the entire plant was constructed by day labor under the supervision of Mr. Brossmann.

The Pittsburg municipal plant, which was also designed by Messrs. Brossmann & King, has a minimum capacity of 500 sq. yd. in 10 hr., but this capacity can be increased considerably by the addition of another melting kettle or by forcing the two present kettles. The plant is in a two-story timber-frame structure, 40 x 46 ft. in plan, which has a corrugated-iron roof and sides of the same material.

The plant is equipped with a conical rotary sand drier and heater of the Blake type. This drier has a dome-shape shell of heavy steel plates which is lined in the drier body with asbestos cement held in place by expanded metal. The interior of the drier is without obstruction or shafting, the sand being agitated by baffle irons placed longitudinally through the drier and attached to the inside of the shell of the latter. Crude oil is used for fuel. Combustion takes place in a fire-brick lined chamber, the heat from this chamber passing through and then around the dryer. Forced draft is supplied by a blower with a 10-in. outlet, the blower discharging into the draft tubes of the combustion chamber. These tubes are arranged so cold air can be admitted in the desired quantity to temper the heat supplied to the sand drier. By means of by-pass flues the sand can be kept at the required temperature. This method of heating, Mr. Brossmann thinks, precludes the possibility of burning the asphalt by overheating the sand.

The arrangement for handling sand and stone through this plant is very similar to that of the Cincinnati plant. The materials are elevated to the charging end of the drier by an elevator and after passing through the drier are raised to an elevated screen by a second elevator. The latter is increased with steel to prevent the loss of heat and the sifting of dust. The heated sand is discharged over the screen, the screened material dropping into a bin in which it is kept at an even temperature by steam coils.

The asphalt is elevated to the second floor by a barrel elevator and is melted in two steam-jacketed kettles having a combined capacity of 7 tons. These kettles are each 12 ft. long and 4 ft. in diameter, the material being agitated in them by mechanical means and by compressed air. The air is supplied by an 8-in. Westinghouse compressor in the boiler room of the plant. The kettles are designed for low-pressure heating, the steam being superheated to the required degree by a superheater of the same type employed in the Cincinnati plant. This superheater is in the boiler room and is supplied with steam at 10 lb. pressure through a Mason reducing valve. The method of using superheated steam for melting as followed in both these plants avoids all danger, Mr. Brossmann said, of altering the chemical constituents of the asphalt by charring or burning as is likely to occur with directly-fired melting tanks unless great care is exercised in the operation of the latter.



Front Elevation and Section of Superheater.

The mixer is placed directly under the storage bin for heated sand and is of the Blake type. It is arranged for producing the standard asphalt mixtures, or bituminous concrete, being provided with four charging buckets, two for screenings and two for the melted asphalt. Two of the buckets are above the others and discharge into a small mixer located above the main mixer. In making bituminous concrete the proper amounts of screenings and melted asphalt are mixed to a thin consistency in the small upper mixer; a fairly dry concrete is made of crushed stone and asphalt in the large mixer at the same time. The asphalt mortar in the upper mixer is then dumped into the lower one where it is incorporated thoroughly with the dry concrete, and then the whole mass is dumped into a wagon on the roadway under the elevated platform on which the mixer stands. In making standard asphalt mixtures the upper mixer and buckets can be removed and the lower mixer used alone.

A feature of this plant is the steam-heated knife provided for cutting such materials as Texas asphaltic compounds, which cannot be cut with an axe, before putting them into the melting kettles. The old method of heating a knife in the fire and then requiring several men to operate it was considered crude so this steam-heated knife was designed to save labor. The knife consists of a length of extra heavy 4-in. pipe, about 10 ft. long, which is pressed nearly flat and has one edge sharpened. A steam connection is made at the upper end of this hollow knife and a drip is provided at the lower end. The latter is attached to the stem of a 4 x 4 x 4-in. tee, the legs of which are hinged on bearings rigidly fixed to the floor; the other end is fitted with a handle. Superheated steam is used in heating the knife, which is always ready for service and has proved a great time and labor saver.

Power is supplied to operate the plant by an 8.5 x 12-in. Leffel engine running at a speed of 240 r. p. m., the engine room being directly under the melting kettles. Economic type boilers made by the Erie City Iron Works and operated at 100-lb. pressure are installed.

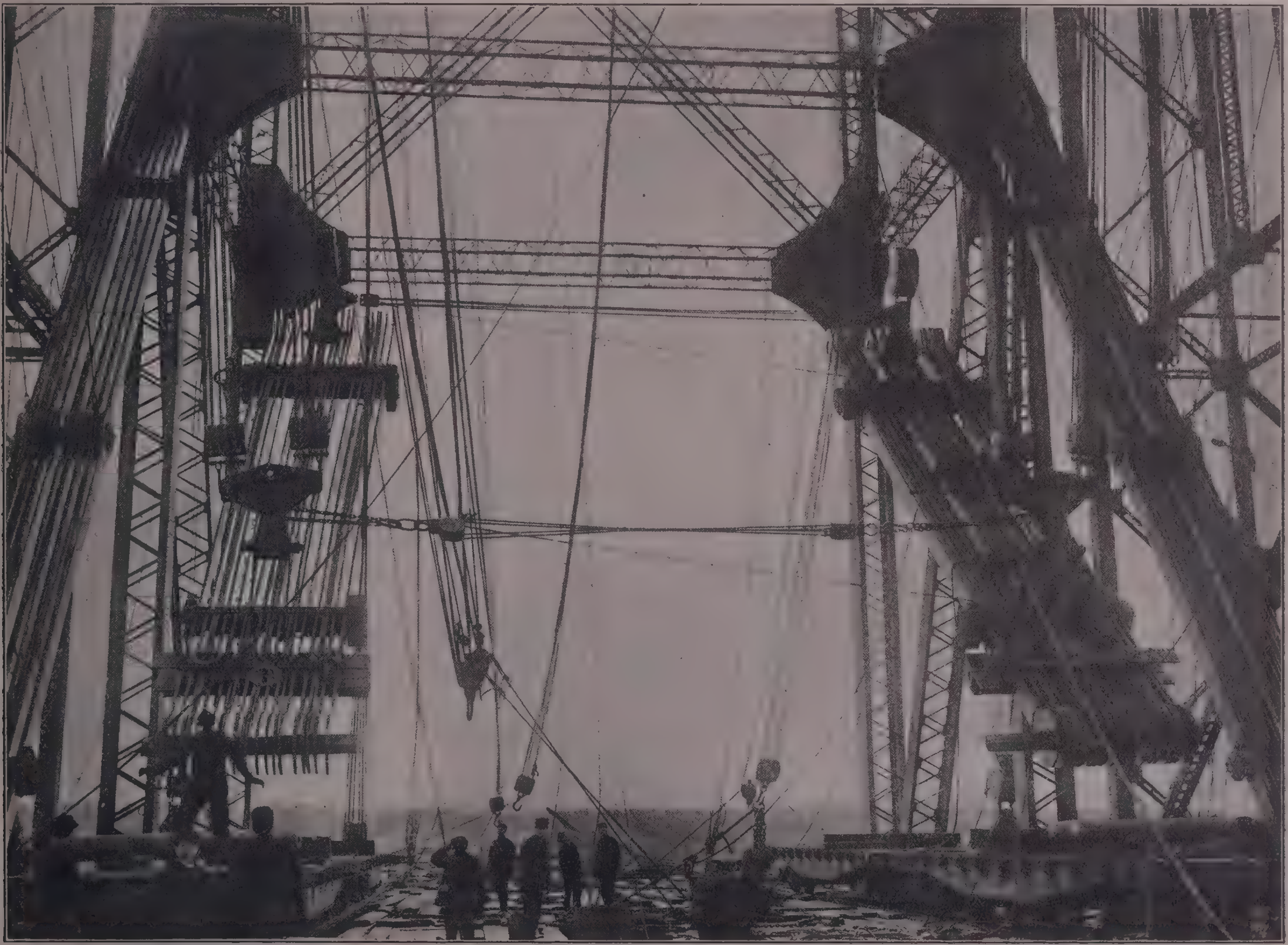
Improved Pavement Foundations.

Reinforced-concrete pavement foundations are being used over refilled trenches in Easton, Pa., by Mr. John McNeal, Jr., city engineer. The specifications require that after the trench is properly back-filled, the old concrete shall be removed at least 1 ft. on each side of the trench, and expanded metal placed over the entire opening. Six inches of 1:3:5 concrete is placed over and around the expanded metal so that its is imbedded 1½ in. above the base. After the concrete is thoroughly rammed to an even surface 2 in. of sand and the bricks are replaced on to conform with the adjoining paving. The expanded metal used must be not more than 3-in. mesh and No. 10 gauge steel and must have a cross-sectional area of not less than 0.185 sq. in. per foot of width. It has been calculated that a 6-in. slab of concrete 20 in. in width reinforced in this manner and supported on both sides will sustain a wheel load of 670 lb., even if there were no back filling, assuming the working stress of the steel to be 20,000 lb. The cost of making repairs over a trench 20 in. wide is given as follows: Removal of old concrete for a width of 12 in. on each side of opened trench, about one-half cent per square foot; expanded metal of 3-in. mesh and No. 10 gauge steel, 4½ cents per square foot; concrete, 10 cents per square foot.

A Three-Phase Electric Railway has recently been placed in operation in Canada between London and St. Thomas, Ont., which is the first three-phase system of the Ganz type operated in America. The current is generated and transmitted at 10,000 volts, and reduced in transformers along the line to 1,000 volts. There are two trolley wires, the rails forming the third conductor.

Handling Eyebars at the Quebec Bridge.

In continuation of the articles on the Quebec cantilever bridge which have appeared in recent issues of this journal, it is proposed at this time to describe the methods of handling the large eyebars in this structure. There are about 2,500 of them, 15 and 16 in. wide and 1⅜ to 2⅛ in. thick. Their lengths vary from 50 to 76 ft. and their total weight is about 7,500 tons. Those in the anchor arm are combined in groups of from 20 to 28 to form diagonal and top chord members, proportioned for unit stresses of 13,000 to 17,000 lb. with combined areas of 142 to 711 sq. in. For convenience in erection and assembling, all of the eyebars in any given member are clamped together at the storage yard and handled as a unit, except at the river-end top-chord panels nearest the pier post, where to swing clear of trusses and secure narrower widths they are handled in three groups for each panel.



Hoisting Two Assembled Top Chord Panels Simultaneously.

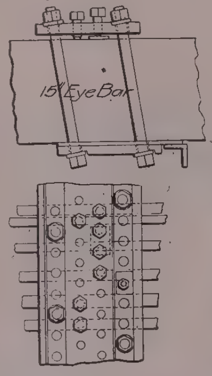
The eyebars for a given member are selected and carefully arranged in proper sequence in vertical planes on horizontal skids. About 5 ft. from the center of the pin-holes at each end, a steel clamp is assembled around the bars and set tight enough to maintain them in the vertical plane and enable the spacing to be accurately adjusted. The clamps are then screwed tight and sets of wooden spacing and stiffening fillers are inserted between the vertical faces of the bars in a line about 4 ft. clear of the clamp and held in position by a yoke consisting of a pair of vertical transverse timbers on opposite sides of the group, connected by horizontal bolts screwed tight.

In the space between each clamp and yoke, a lifting beam is placed underneath the eyebars, with short vertical links connected to it and passing up through spaces between the eyebars to engage a transverse pin for connection with the hoisting tackles. The vertical links, being pivoted at the top and bottom to horizontal pins, transverse to the axis of the eyebars, are free to revolve in a vertical plane and permit the eyebars to be hoisted or adjusted to any desired angle conforming with their position in the diagonal members or top chord. This arrangement assures, first, the positive maintenance of all bars in the exact relative position required for their spacing to correspond with the required packing on the chord pins, and, second, proper clearance for the other members assembled on the same pin. It also stiffens the bars so that they can be handled readily and make comparatively rigid jaws interlocking with the corresponding bars from the adjacent panels on the chord pins, thus greatly promoting the convenience and rapidity of assembling the joint.

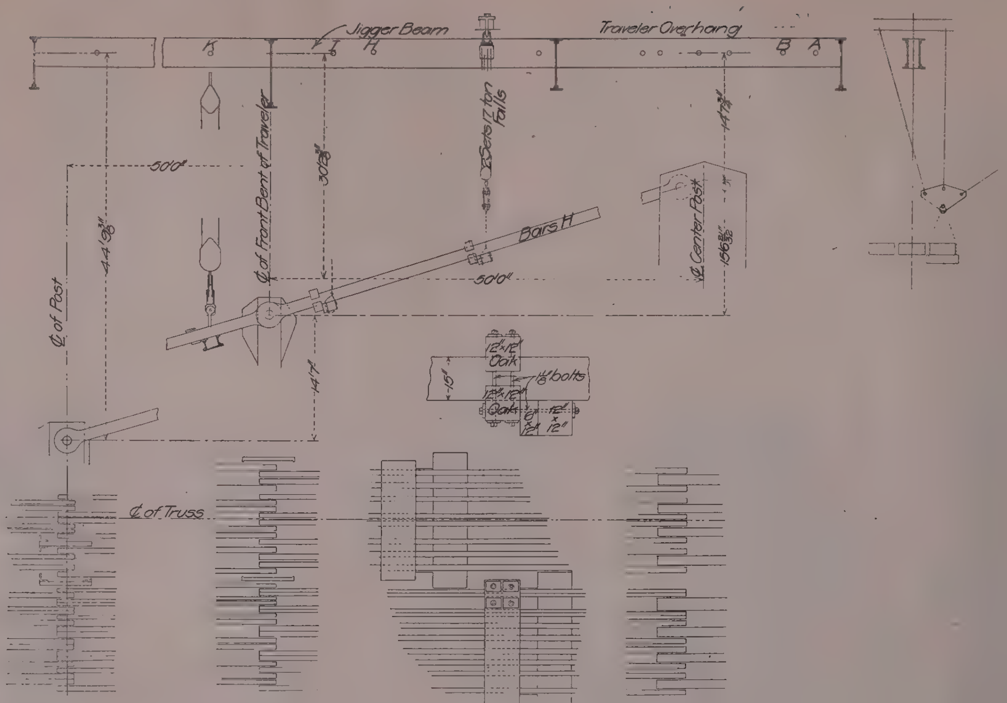
The lifting beams are simply and efficiently secured to the group of bars at the most advantageous points for lifting them and diminishing the flexure of the bars. Buckling in the compound member is avoided, and the attachments are so made as to clear the connections and afford ample facilities for driving the pins and setting the members together; at the same time provision is made for swinging the bars horizontally or vertically, and adjusting them accurately to any angle or position.

The clamps nearest the ends of the bars have two wide flat steel plates long enough to extend across the full width of the assembled member on the upper and lower edges of the eyebars, which are connected together by bolts through the interstices between the eyebars, making a slight angle with the normal to the plates corresponding to the relative positions of the latter, that of the upper edges of the bars being slightly nearer the end than the lower one. This arrangement produces a skew in the clamping that tends to tighten the plates and increase the friction when the inclined position of the eyebars develops a longitudinal stress tending to produce sliding in the lower plate. The upper plate is made from a 15x1 11/16-in. bar with a longitudinal beveled groove planed in each edge of the upper surface to afford bearing for the nuts normal to the bolts. The lower plate is made with a similar bar countersunk-riveted to an 18x 7/16-in. plate on its upper surface. Both bars are drilled with holes 3 in. apart in each slot to receive the clamping bolts, which are in different positions according to the clearance between the eyebars in different members. These holes are tapered from 1⅝ in. to 1¾ in. diameter in the thickness of the bar. There are also between these holes in the upper plane two rows of staggered holes 1½ in. apart, tapped for 1⅜-in. stud bolts which are set in them as occasion requires to take bearing on the edges of the eyebars in different positions.

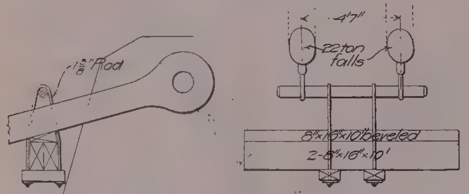
The lower plate is provided with longitudinal and transverse lug angles for connection bolts to the lifting girder. When the clamps are assembled to the eyebars, the 1½-in. bolts are inserted through the tapered holes, preferably not more than 12 in. apart. They are provided with special heads and nuts with conical turned bearing surfaces which engage corresponding turned steel washers seated in the grooves of the clamp plates. The bolts are set to bring the bottom plates in contact with the lower edge of the eyebars and leave a clearance of ½ in. between the upper edges of the bars and the top plate. As many set screws are put in the top plate as will engage the edges of the bars and are screwed to bearing against them; 6x8x½-in. plates are inserted between the edges of the bars and the upper clamp plate, and the set screws are operated on them to engage the bars. By this means all of the bars are rigidly secured in the clamps in their proper relative positions, and all of the screws are tightened until they develop sufficient friction to prevent any possibility of displacement. When the spaces between the 1½-in. tie bolts are more than 12 in. long, intermediate 1-in. bolts are also used wherever they can be entered.



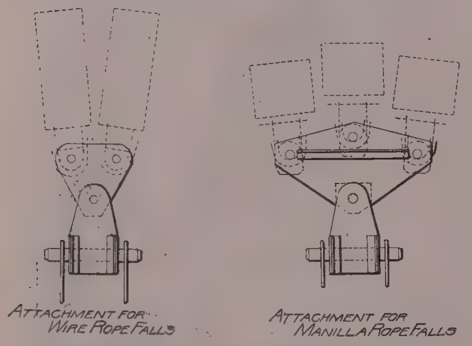
Spacing Clamp for Eyebars.



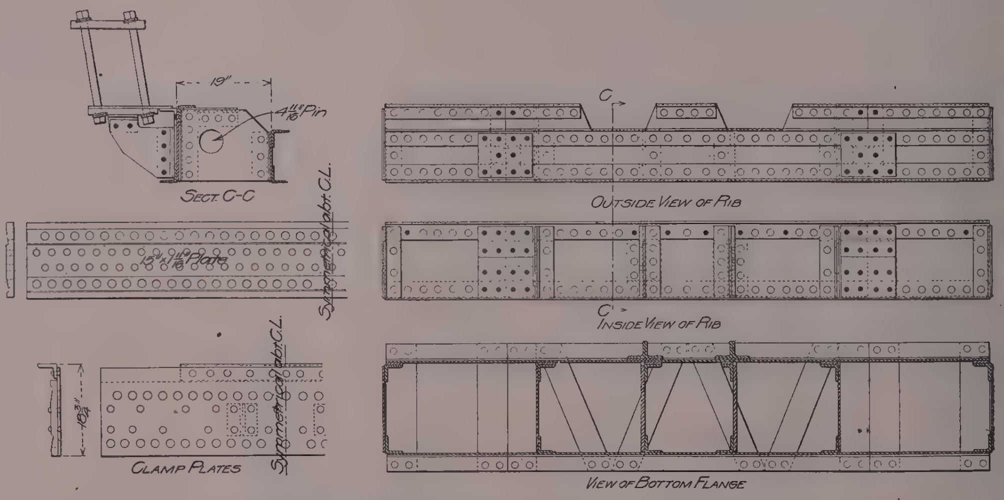
Hoisting Eyebars in Last Top Chord Panel of Anchor Arm.



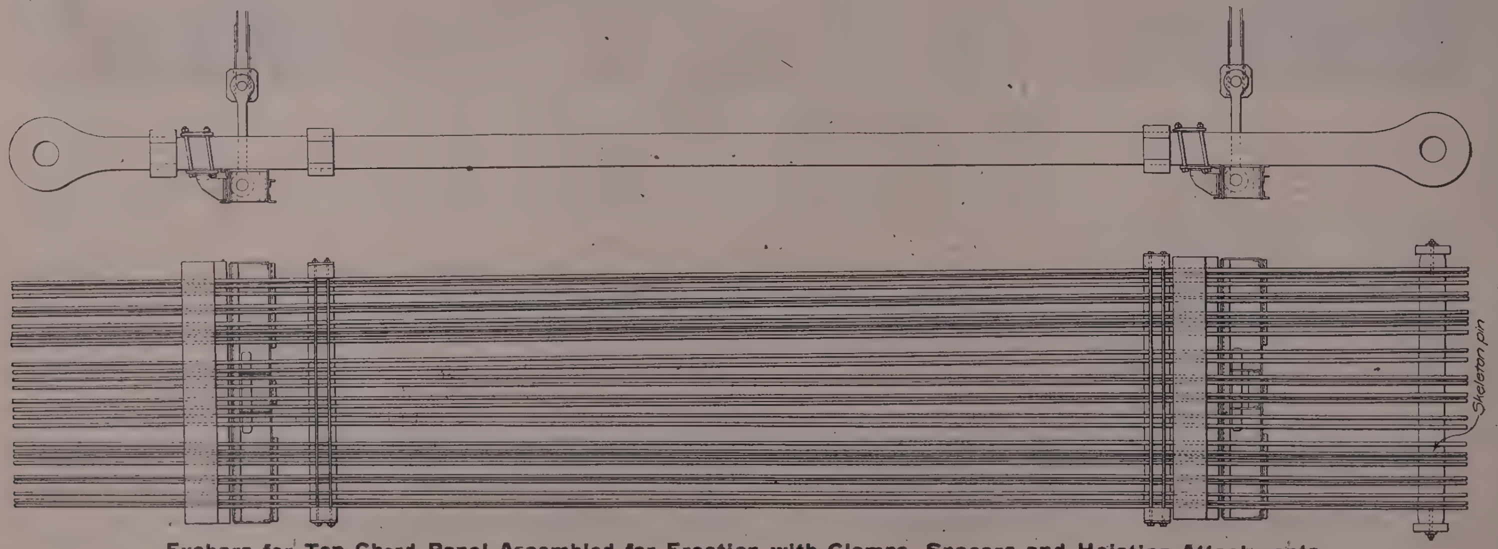
Alternative Attachment for Temporary Support.


ATTACHMENT FOR WIRE ROPE FALLS
ATTACHMENT FOR MANILLA ROPE FALLS

Attachments for Hoisting Eyebar Groups.



Girder for Main Eyebar Hoisting Attachment.



Eyebars for Top Chord Panel Assembled for Erection with Clamps, Spacers and Hoisting Attachments.

The lifting beam between the clamp and the filler yoke has a rectangular cross-section made of two built channels 10 ft. long, 15½ in. deep and 18 in. apart back to back. They are connected by four intermediate and two end transverse vertical diaphragms, and are provided on the lower side with bracket plates field-bolted to their web stiffeners and to the connection angles on the clamp plates. These connections possess considerable tensile strength and secure the lifting beams from slipping upwards when the eyebars are in an inclined position. The two center diaphragms are bored to receive a horizontal 4 11/16-in. pin parallel to the axis of the beam, which engages a pair of short vertical I-beams or links passing between the main eyebars and engaging a transverse pin, on which is assembled between them a short riveted box with the two side plates parallel to the pin projecting above it to form jaws pin-connected to the hoisting tackle connection.

Two forms of tackle connections are used. One is for two wire-rope tackles and consists of a pair of triangular plates connecting with 3 pins, the lower one for the jaws of the lifting device and the upper two provided with cast-iron yokes or bushings to fit the shackles of two wire-rope hoisting tackles, as indicated in the drawing. The other type is made with wider plates and four pins, the lower one for connection to the hoisting attachment and the upper three for connection to the manila rope tackles.

Driving 12-Inch Top Chord Pin 375 ft. Above Water.

In order to release the hoisting girders and provide means for handling the ends of the eyebar groups when the second pin is driven, another connection is provided, which consists of a pair of 8x16-in. transverse wooden beams 10 ft. long, with a beveled wooden filler or cushion on top, which are placed transversely under the upper ends of the eyebars. Cross pieces under the beams receive the lower ends of the U-bars, engaging the beams and having nut bearings on them. These U-bars pass up through interstices between the eyebars and receive in their loops a 6-in. pin 7 ft. long, to the projecting ends of which the shackles of 32-ton tackles can be attached. Eventually the number of steel hoisting beams was increased and these attachments are not always used.

The twenty-eight 15x2 11/16-in. eyebars about 50 ft. long in each top chord panel at the river end of the anchor span have a combined weight of about 140 tons, and for convenience in hoisting and assembling they are clamped together in three sets arranged as indicated by the half plan and cross-section symmetrical about the center line. The steel clamp bars previously described are so long that they would project beyond the edges of these groups and interfere with their assembling, therefore they are here replaced by simple wooden clamps made with 12x12-in. oak beams projecting 5 in. over the edges of the bars and held in position by pairs of 1⅛-in. bolts at each end. The spacing is maintained by oak fillers between the bars. Three sets of clamps are used. To the one in the middle there is bolted a 6x12-in. and a 12x12-in. hoisting beam, to which the connections for two sets of 17-ton manila tackles are secured by double 1½-in. chains passing through the interstices between the eyebars. A single tackle is attached to each of the end clamps by a 1½-in. chain passing between the eyebars and around the lower clamp timber, as shown in the elevation diagram.

In erection, the eyebars in top chord panel *G*, second from the river end of the span, were assembled in the usual manner to the top of vertical post *P4* at the shore end, and the river end was supported by tackles attached to the steel hoisting beam and clamp, and suspended from the jigger beams in the traveler at the point *K*. Other steel rope tackles were connected to the jigger beams at points *B*, *F*, *H* and *A*, and a 22-ton manila tackle was suspended at point *N*. The center group of eight bars in panel *H* at the river end of the span were assembled and hoisted as indicated on the drawings, and the upper end was first entered in the top of the pier post *P0*. The lower end was entered in the top of the subvertical post *SV5*, and the pin there was driven as far as it could go without entering the bars. The upper ends of the eyebars were lowered to rest on the post diaphragm, and a transverse timber was put through the pin-holes there. A tackle was then attached to the shore end and all other tackles were disengaged.

The center group was erected in the same manner and the pins were driven as far as possible, and finally the outside group was erected and the panel completed. One of the 17-ton tackles at the center of the eyebars was suspended at a point inside the plane of the truss and the other was suspended at a point outside the plane of the truss, so that they could be operated to swing the bars transversely from the position to which they were hoisted clear of the truss to the final position in the plane of the truss. A third tackle was attached to the bars at this point and led to the center line of the traveler, so as to hold the bars away from the truss until they were hoisted to the full height, when it was slacked off as the outside tackle was operated and thus fleeted the bars to position.

The groups of eyebars for two corresponding members in each truss were brought in simultaneously on two or three steel flat cars on the service tracks on both sides of the bridge. The hoisting tackles were attached to them, and both members were hoisted simultaneously to position to the maximum height of about 370 ft. above low water. The hoisting was done at a speed of about 12 ft. per minute while the engines were in actual operation, and the members were lifted the full height from the car to the final position in from 5 to 15 minutes, all operations being directed by the signals given by the foreman who motioned with his hands to an assistant who repeated the gestures to the engine drivers in the base of the traveler. The erection was accomplished with great facility and without delays or difficulties in handling or assembling.

The diagonal members were handled in the same manner as has been described for the top chords except that instead of a third tackle attached to the center line of the traveler for use as a back stay in fleeting the members there were connected together by horizontal transverse manila hand tackles, attached to the connections for the hoisting tackles with their lead lines made fast to the bars. These tackles held the bars together about 55 ft. apart on centers, and thus drew the hoisting tackles somewhat out of the vertical. Men rode up on the eyebars as the latter were hoisted, and at the proper time released the lead lines and allowed the members to swing back to the vertical planes and be pulled over to position in the planes of the trusses. Where the diagonal eyebars are made in two lengths between main panel points, both lengths are assembled, their intermediate pin permanently driven and the bars assembled and clamped in a single group on the skids and erected as a unit.

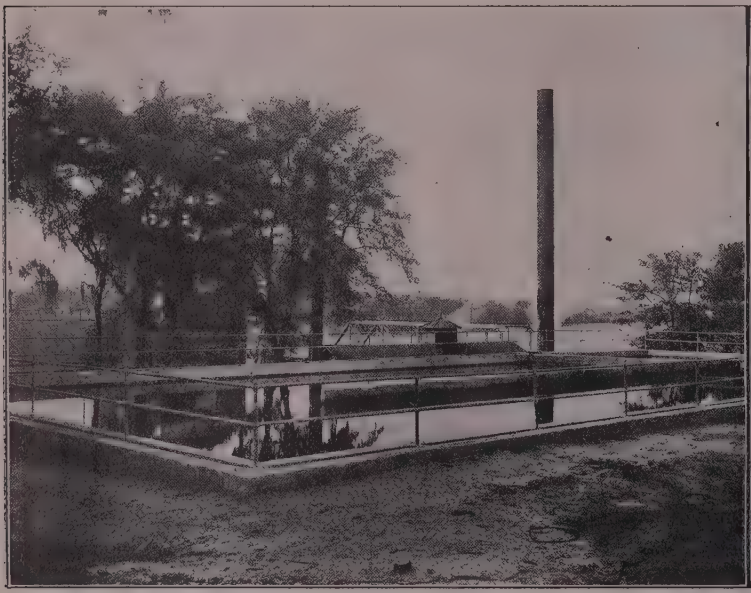
Hydraulic presses were provided for driving the pins, but so far it has not been found necessary to use them, and all pins have been driven in the usual manner by a battering ram suspended from above and operated by a number of men on an enclosed platform also suspended from the overhang of the traveler. The provisions for delivering, assembling and holding the members in position, and the accuracy with which the eyebars were clamped together have made the joints so perfect that no difficulty has been experienced in driving the 12-in. pins of a maximum length of nearly 12 ft. and engaging in some instances about sixty separate bearings.

Mr. E. A. Hoare is the chief engineer, and Mr. Theodore Cooper the consulting engineer of this bridge. The contractor for the steelwork is The Phoenix Bridge Co., Mr. John Sterling Deans, chief engineer, and Mr. A. B. Milliken superintendent of erection.

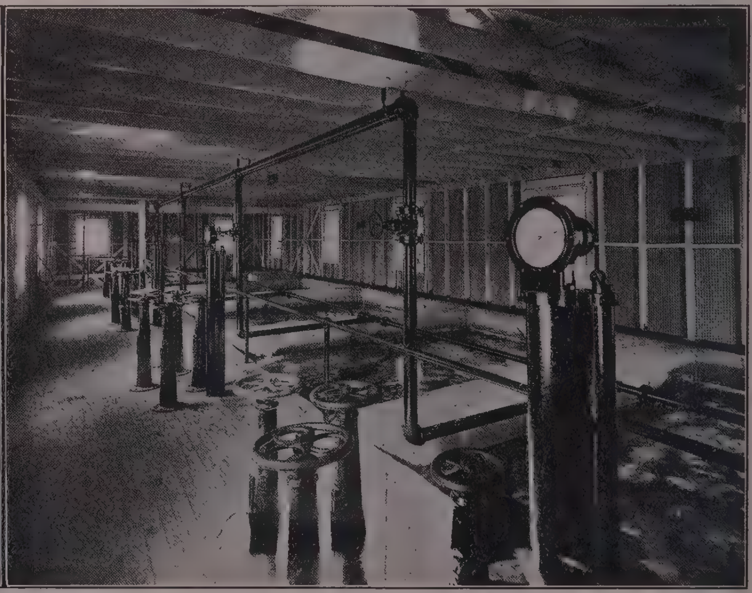
The Panama Canal Laborers from the West Indies are with difficulty induced to eat enough food. According to Mr. Theodore P. Shonts, who recently resigned the chairmanship of the Canal Commission, no price for food can be low enough to induce these negroes to eat a sufficient quantity to keep them in good physical condition. Cooked food at 10 cents per meal and the uncooked ingredients at a price reduced by the cost of cooking and serving were offered them. Both plans resulted unsatisfactorily. They would not go to the trouble of cooking free uncooked food and only when given cooked food free did they eat heartily. Beginning Jan. 15, Mr. Shonts said, these laborers have been paid a fixed wage and three meals a day. It is hoped that the result will be a betterment of their physical condition and a consequent increase in their working efficiency and ability to withstand disease.

The Mechanical Filtration Plant at Wilmington, N. C.

By A. O. True, S.B.



General View of the Coagulating Basin.



Arrangement of Four Filtering Units.

Judging from the activity for the improvement of water supplies and the number of filtration plants recently constructed in the Southern States, it would seem that the South is taking a prominent part in the scientific development of the water resources of the country. It is encouraging to note these steps in advance, for they clearly indicate a growing appreciation of the intelligent control of what are justly recognized as our greatest resources. It means that the realization of the economic value of pure water is becoming more general.

In studying the value of a water supply to a community, four considerations must be taken account of. The first and most important of these is the sanitary quality of the water; second, the value of the water from an economic and industrial standpoint; third, the adequacy for future as well as present demands; fourth, the consideration of the supply from an æsthetic standpoint; that is, whether it is clear, cool, sparkling and inviting to the senses or otherwise. That the first of these considerations is as much an economic one as any of the others is well shown in a paper by Mr. F. B. Leopold under the title "Water Purification and its Relation to Municipal Health and Prosperity." Experts in the physical and chemical properties of water readily appreciate the detrimental effects of undesirable substances on the money value of a water supply, and some of our leading sanitarians have gone so far as to deduce mathematical formulæ by means of which these losses can, in a measure, be ascertained.

Wilmington, N. C., the largest and most important commercial city in the State, has a population of about 30,000, and is situated on the left bank of the Cape Fear River, about 20 miles from its mouth. The city lies just below the junction of the Northeast Cape Fear River with the Cape Fear River, and slightly above a long estuary which extends southerly to the river mouth. Previous to the installation of the filtration plant, water was pumped directly from the Northeast Cape Fear River at an intake somewhat north of the city. Just below the intake the northwest branch of the river unites with the northeast branch. Both streams are backed up by the incoming tide, so that on the flood tide the water reaching the intake is a mixture of the water from both branches of the river. On the ebb tide the supply is wholly from the northeast branch. Since the physical characteristics of the water in each stream are markedly different, the water at the intake shows wide physical variations at different stages of the tide. The water of the northeast branch is highly colored yet clear, whereas that of the northwest branch is light colored and turbid. At high water, then, the water delivered to the city was, before filtration was esablished, not only subject to the two undesirable characteristics of color and turbidity, but also to the more dangerous one of sewage contamination from the outfalls below, especially, during abnormal tides or low stream flow.

As the river has a large watershed, the supply is seemingly adequate for all future needs, and the question of improvement was confined to the best treatment of the present supply for both present and future demands. From available data it appears reasonably certain that at present the river at Wilmington is not subject to dangerous pollution from either the sewage of upstream communities, or from the wastes discharged from the city itself. It is not likely, however, that such apparently favorable conditions will always obtain, because of the increase of population, unforseen tides and other factors which materially affect the sanitary condition of a watershed.

The Cape Fear River water is comparatively soft, but high in color and tubidity, as before stated. The color is due, in most part, to organic matter of the peaty or swampy type in solution, as is common in surface supplies which have passed over marshy land, thereby becoming stained by the products of recomposition of plant life. These waters of the "meadow tea" type, while perfectly safe so far as color is concerned, are often objectionable to the consumer, being unsightly and often having a "marshy" taste. The high turbidity, due to the presence of large amounts of clay and silt, was a serious detriment to the commercial value of the supply, besides being undesirable to the consumer for household uses.

Water which is high in color and turbidity, such as that of the Cape Fear River, is more readily and economically treated by the mechanical process of filtration. First, the coagulant, usually either sulphate of iron or sulphate of alumina, used in this process absorbs a large percentage of the color which exists in the water in colloidal solution. Second, the large amounts of fine clay and silt, which rapidly clog the sand layer, are effectively disposed of by the frequent washings economically permissible in a mechanical filter.

Efficiency commensurate with low initial cost and reasonable cost of operation being the chief desiderata in the installation of the Wilmington filtration plant, no attempt was made at elaborate design.

The plant consists, in the main, of three parts—the coagulating basin, clear water well and filter house—all being situated near the intake and the water company's power house.

The coagulating basin, where the river water is received direct from the intake, is entirely of concrete construction with the foundations taken well below the ground level. The basin is rectangular in plan, and has a capacity of 360,000 gal. Its length is 100 ft.; width, 40 ft., and depth, 12 ft. This coagulating basin affords about 4¼ hours sedimentation when the plant is running at its full capacity of 2,000,000 gal. per 24 hours. It will be noticed that this is considerably in excess of the average length of sedimentation provided for in a plant of this type. This was deemed advisable in view of the large amounts of clay, silt, etc., contained in the water, as before mentioned. The basin is divided longitudinally by a baffle wall 65 ft. long. A collecting trough delivers the water to the outlet pipe leading to the filters which are fed by gravity.

Pipe Gallery Under Operating Floor.

Exterior View of Filter Building.

The clear water well is 40 ft. distant from the coagulating basin, with foundations 25 ft. lower than the latter. This well, together with the filters, forms the substructure for the filter building. The clear water well is of concrete, 70 ft. long by 15 ft. wide, and 18 ft. deep. Its capacity is about 117,500 gal., which represents 1½ hours' supply for full capacity.

The filters consist of four rectangular reinforced concrete units each 15 ft. long, 12 ft. wide and 8 ft. deep, each unit having a normal capacity of 500,000 gal. per 24 hours. These units are arranged in a single row and occupy about two-thirds of the width of the building. The filters rest directly on the walls of the clear water well, but are supported in a large measure by transverse concrete arches and beams designed to carry their weight when loaded with the filtering sand, water and pipe systems.

Directly beneath the operating floor is the pipe gallery, a view of which is shown in an accompanying illustration. All the large piping, which is connected to the filters, is brought through this gallery and so arranged that the valves can be controlled from the floor stands above by means of extension rods. Here also are located the effluent controllers, one for each filter unit, whose function is to maintain a uniform rate of flow through the sand layer.

The superstructure is of wood with the exception of the exterior, which is covered with corrugated sheet steel. The over-all dimensions of the building are 72 ft. in length, 24 ft. 3 in. in width, 16 ft. 3 in. height from the top of the wall to the eaves in the main building, and 30 ft. from the top of the wall to the eaves at the tower.

The main portion of the building contains the filters, operating floor and pipe gallery. The lower part of the tower constitutes the machinery room, whose floor is about 8 ft. lower than the operating floor, and is connected to the latter by a flight of steps. The upper part of the tower is occupied by the chemical plant, which is situated at as high an elevation as possible in order to obtain the necessary head to feed the solutions by gravity to the sedimentation basin. This upper room of the tower also affords storage for the chemicals used in the operation of the plant.

The mechanical equipment of the plant consists of a 2,000,000-gal. centrifugal low lift pump for delivering the raw water to the coagulating basin, and a pressure blower for agitating the sand in the filters while washing, and also agitating the contents of the solution tanks. Both the pump and blower are driven by direct-connected vertical engines. The steam supply for these machines comes from the adjacent power house of the water company.

The coagulant plant consists of two units, one being used for sulphate of alumina and the other for soda ash. Each unit is made up of two circular wooden tanks, an orifice feed box and a pipe line to the coagulating basin. The line carrying the alum solution is of lead-lined wrought piping. The function of the orifice feed boxes is to regulate the rate of flow of the solutions from the tanks to the coagulating basin.

Preliminary experiments with a sample of Cape Fear River water showed that decolorization could be effected by the use of about 2 grains of sulphate of alumina per gallon. Water thus treated and filtered retained but about 15 parts per million of color, this being a reduction of more than 80 per cent.

The softness of the Cape Fear River water necessitates the use of about one-half a grain per gallon of soda ash to decompose the alumina.

The results of the chemical and bacteriological tests which were made to determine the efficiency of the filter plant are most favorable. These tests were made shortly after the plant was in running order and extend over a period of seven days.

Average Results of Tests; Parts per Million.

	Raw-Water.	Filtered-Water.
Color	194	19
Alkalinity	11	4.5
Incrustants ...	11.6	24.5
Total hardness.	22.7	29.1
Turbidity	19 Geol. Sur. St'd.	1.1 Geol. Sur. St'd.
Odor	1.2-V.	0.6-V.
Bacteria	1770 per c.c.	55 per c.c.

The average amounts of coagulants used were, sulphate of alumina, 2.18 grains per gallon, soda ash ½ grain per gallon.

It will be seen that the Cape Fear River water had, at the time these tests were made, less than 3,000 bacteria per cubic centimeter, as determined by standard methods. In this country it is general among sanitarians to require that waters of this class should show less than 100 bacteria per cubic centimeter when filtered, where sanitary efficiency is looked for. The tests show that the number of bacteria in the filtered water at Wilmington was well within the sanitary requirements.

The plant was built for the Clarendon Water Works Co., of Wilmington, N. C., by the Pittsburg Filter Mfg. Co., of Pittsburg, Pa.

The Sanitation of Air.

In crowded industrial and commercial centers, the excessive vitiation of the atmosphere has grown to be an important factor bearing on public health. While a systematic supply of pure air to buildings has long been recognized as a necessity, the state of the outer air has not yet received the attention it deserves, and is too often accepted as a matter beyond control. An inquiry into the sources of its pollution will readily show that much of it might be prevented; and an instructive paper on this subject has been contributed recently to the "Popular Science Monthly," by Mr. Konrad Meier, whose experience as a heating and ventilation specialist makes his views deserving of careful consideration. The following notes give several of his opinions, as expressed in that paper

Recent experiments by Fluegge, the eminent German investigator, make it appear that the paucity of oxygen and the simultaneous increase of carbonic acid and other waste products, have no appreciable ill effect on the average adult, but that the depression of spirits, headache and drowsiness felt in crowded, ill-ventilated assembly rooms are principally due to disturbance of the thermal functions of the body through heat and moisture. It has been asserted that the human organism has long been used to the frequent breathing of foul air, and will adapt itself to any condition tolerable at all in the long run. This is true to an extent, as to the products of breathing as well as to temperature, but it is more than likely that any immunity from the habit of living in badly used air is gained at the expense of vitality.

As distinguished from "exhaustion" of air, or shortage of oxygen, with the corresponding increase of carbonic acid and other waste products, the term "contamination" may be applied to impurities of gaseous and solid nature, aside from the normally unavoidable. This includes, for instance, gases and vapor from industrial sources, also smoke, soot and dust with its attendant bacteria.

The amount of carbonic acid found in air is commonly regarded as a measure of the degree of vitiation, but wherever pollution of the air is likely to occur independent of an increase of combustion or respiration, that method of testing the purity naturally is deceptive. Indeed, contamination quite often predominates exhaustion, and should always be considered by itself, as a separate factor, according to the nature of the case. While the effect of exhausted air may have been over-estimated, the bearing of contamination on health does not seem to be sufficiently realized. Its claims on vitality are of a different nature. Any admixture of foreign gases may react directly upon the blood. Such poisoning, however, is mostly due to local sources, readily detected and prevented. By far the greater mischief is done by the solid impurities afloat in the air. Although these are normally arrested by the moist, mucous surfaces of nose and throat, they will, under certain conditions, enter the lungs, fill the minute air chambers and lodge there indefinitely. Through life in smoky or dusty surroundings large portions of the lungs become useless in this manner, invite decay and the fatal attacks of bacteria. Dr. Louis Ascher, in publishing the results of his exhaustive investigations on the subject, has shown conclusively that smoky atmosphere encourages diseases of the respiratory organs, materially shortens the life of consumptives and bears distinctly on the mortality of afflicted districts. The charts of distribution of pulmonary tuberculosis in Chicago show the cases to be most frequent near the cluster of railway stations.

Still greater mischief is done by solid impurities, especially dust, as the carriers of disease germs. True, the best authorities now agree that the presence of microbes in the respiratory organs does not necessarily produce disease, and that the germs must first make their way into the system in order to develop, and find it in poor condition before they can do serious harm. Predisposition, in the form of inflammation combined with lowered vitality, seems, therefore, necessary to develop the more serious pulmonary diseases.

A good crop of pneumonia and kindred diseases seems assured for the winter season, when the tax on vitality is severest, and indoor life in unsanitary quarters supplies the opportunity. This seems almost sufficient to explain the present situation in our large cities, which has brought about the organization of the Pneumonia Commission through the New York Board of Health. In this connection Dr. Herman M. Biggs, the general medical officer of the board, has stated that the number of victims claimed yearly by pneumonia increases steadily and alarmingly. In New York City alone during the first six months of 1905 one-third the total number of deaths were charged to acute respiratory diseases and pulmonary tuberculosis. During that period the deaths from these causes numbered 14,091. In the corresponding period of the year before they aggregated 10,890.

When we compare the efforts of the sanitary corps in this particular direction with the systematic and thorough work done in checking certain epidemics, we cannot fail to note the lack of a comprehensive system in fighting diphtheria, grip, pneumonia and other respiratory diseases, which now claim a majority of victims. The situation seems to be recognized, but is met only to a limited extent.

The sources that contribute to the pollution of urban atmosphere naturally increase with the population, while the dispersal of impure matter by the natural air currents becomes more sluggish and uncertain with the growing areas of urban settlements. The density of population in certain metropolitan districts is easily ten times that of smaller cities. The rate of vitiation of the air through smoke and other waste matter must, therefore, be at least that much greater. In cities, where dwellings and shops are built not only closer together, but are literally piled up on each other, the general contamination is likewise bound to become unwholesome unless special care is taken in disposing of waste matter that may find its way into the air. No doubt more is being done in this direction than in former days, but the rapid concentration of living quarters and industrial shops brings with it new conditions.

Smokeless combustion is not only feasible for almost any kind of coal, but more economical if properly attended. The principal difficulty exists in the design of the proper furnace to suit the fuel and to meet the conditions under which it is burned. There ought to be no restriction on the use of bituminous or any other coal. On the other hand, no excuse should be accepted for black smoke from any source within city limits.

Dust of the streets is one of the principal elements in polluting the atmosphere. It is made up of innumerable substances utterly defying description. To what extent it permeates the air, even in buildings, is proved by a microscopic examination of deposits from furniture, which shows a large percentage of animal refuse, mostly horse offal, ground up by the street traffic. Concerted action is necessary to suppress this nuisance. No one should complain about dust who is not doing his share in preventing it. A case which illustrates this point is the New York Subway. Dust from the streets, mixed with sputum and sweepings from within, are permitted to accumulate indefinitely on a roadbed of gravel, which can never be thoroughly cleaned. The trains continually stir up some of this accumulation and impart it to the air. This is an inexcusable offense from a hygienic point of view.

Among the numerous factors which may contribute to vitiate the air in buildings, some can always be eliminated, while others are unavoidable and should be counteracted by ventilation, in one form or another. Waste matter of any kind is certain to contaminate the air without necessarily being perceptible by odor or by any of the customary methods of testing. Dust and dried-up sputum from the street, brought in by the air or by clothing, unless frequently removed, will permeate carpets and draperies, from where it is continually stirred up, thus filling the air with all sorts of impurities, irritating and disease-bearing. The stuffy atmosphere one notices when entering certain assembly halls and churches is nearly always due to lack of energy or method in cleaning, quite often through inaccessibility in "dirt corners" or other hygienic fault in the design of buildings.

Since the capacity of air to absorb moisture increases with its temperature, heating, by any method, will have a drying effect. In clear cold weather, when the atmosphere out of doors contains little moisture, the relative percentage indoors may drop below a point to which most persons are acclimated. Unless made up by internal sources, some artificial supply of moisture seems desirable in such cases. It is, however, not necessary and not desirable, as is often recommended, to go beyond, or even as far as, making up the deficiency caused by heating, since the human system is used to considerable changes without any real discomfort. Indeed, dry air, if pure, is probably more beneficial to normal adults than moist air. The principal reason why the demand for moisture in heated rooms has arisen is the irritating effect of floating dust which has been set in motion by the heating system, directly or indirectly. In the worst form this may be noticed with hot-air heating through floor registers, which invite all sorts of rubbish to fall into the flue, only to be dried and sent up again, often directly into one's nose. Radiators also, especially those with inaccessible surfaces, will gather dust. When cold, it will lay there and molest no more than that on furniture, but as soon as heat is turned on, the tiny drops of moisture, which always cling to these solid particles, will evaporate. Free of this weight, the dust is easily set in motion by the currents of warm air rising from the radiator, as may often be seen by the tell-tale shadows on the wall above. Heating apparatus thus contaminates the air with dust and bacteria which otherwise would lay undisturbed and out of harm's way. Moistening of the air will not prevent this to any extent. It increases, in fact, another source of contamination, still too common with modern heating systems—the dry distillation of the organic matter on hot surfaces. This phenomenon has recently been studied by the noted hygienists Professors Esmarch and Nussbaum, who have independently reached the conclusion that organic dust begins to distil or singe when a radiator reaches a temperature of about 165° F., and that this process is rather encouraged by moisture, probably because the hygroscopic matter clings longer to the heated surfaces and is therefore decomposed before it rises up in the air. To reduce the vitiating effect of heating apparatus, we must insist on the moist accessible and simple styles of radiators, on which any dust can readily be seen and is apt to be removed, and on ample heating surfaces of moderate temperature which will tend to avoid the decomposition of organic matter.

Overheating by itself must be considered as vitiating the air; at least in so far as it makes it unfit, or less wholesome, according to some noted hygienists who have thoroughly investigated its effect. It seems, at any rate, to give the air a lifeless quality, which soon imparts itself to the victim of our wasteful modes of heating.

Apparatus for artificial moistening, which is now often installed in connection with heating and ventilating systems, aside from the liaiblity of exceeding the desirable humidity, also gives opportunity for contamination of the air supply. Unless the devices are designed on sanitary principles and intelligently attended to, they are very liable to become foul and malodorous, if not unhealthy.

Like the heating of buildings, artificial cooling may also have unwholesome effects. Special provision must be made for drying the air to keep down the relative humidity in the rooms so cooled. In moist and warm weather it would otherwise reach the saturation point. Such a condition is not only uncomfortable, but can become very unhealthy. The science of artificial cooling is as yet very little understood by the average layman and any devices which do not give perfect control over humidity must be cautioned against.

Ventilating apparatus itself may become a source of contamination if improperly designed, operated or maintained. Air filters have been found, for instance, which were intended to arrest the dust, but actually also arrest nearly all the fresh air. Some of these filters can not be cleaned or renewed without spilling the very impurities collected into the air ducts and thence into the rooms. Mechanical ventilating devices too often defeat their usefulness by lack of control over air currents and temperature, which either puts them out of service, or the persons for whose benefit they were intended.

The last, but not the least, among the sources of vitiation is the presence of animal life or of man. Theoretically, perhaps, this may be called the only unavoidable factor, or the one which must be met by ventilation. The exhalation of carbonic acid in place of the oxygen inhaled reduces the life-giving quality of the air, or its power of regenerating the blood. Exhaled air, moreover, is charged with vapor and organic matter. The substance, effluvia, which emanates from the surface of the human body is also of organic nature. It is harmless enough when permitted to dry and disperse, but in the moist and warm air of over-crowded rooms it quickly putrefies and becomes obnoxious. Whatever ill effects may be due to effluvia come through the action of odor on the nerves, rather than through inhaling this comparatively innocuous matter.

The remedy for the unhealthy conditions described naturally lies in systematic sanitation of the air; indoors as well as out-of-doors. The methods of carrying on such work are indicated by the causes themselves, and some remedies have already been suggested. In regard to open air they are practically limited to measures of prevention.

Particular attention should be paid to the suppression of all markets and other nuisances affecting the salubrity of streets and squares surrounding schools and hospitals. The maintenance of public buildings on strict sanitary lines by systematic processes of cleaning, disinfection, repainting and repairing is also too much neglected. The movement for the better housing of the poor, however much has been accomplished, can only be called a beginning. Hundreds of the better sort of tenements are being built, but thousands are needed. If the Health Board has the right to condemn old rookeries, to order repairs, to pass on workshops in dingy basements and the like, there is much to be done yet on these lines.

The campaign against expectorating, in which Dr. Darlington, the present New York health commissioner, has taken an active part, is most commendable. It certainly reduces the constant danger of infection, but it does not lead far enough toward stopping its causes, the chronic catarrh and other ills largely induced by untidy streets and buildings, public and private.

Sanitary inspection has long been organized in many cities, for certain classes of buildings, but it must include all public conveyances, conveniences, highways and byways in order to be really effective. It should be supplemented by jurisdiction over hygiene in lighting, plumbing, heating and ventilation of new buildings, and in the maintenance of streets, sewers and other public works. This may seem to be a large ground to cover for the average staff of health officers, but it is not altogether a question of men, but one of influence or power of the board over other departments, which should be made to carry out their own work with due regard for hygienic requirements.

The foregoing arguments should have made it clear that ventilation is not the only cure for vitiated air. It should be regarded rather as a supplementary measure, to be used where other means of sanitation can not or will not give sufficient relief. To ventilate buildings with the impure air from city streets, railways cars with smoke from the engines, subway cars with dust laden air from the tunnel, is naturally inefficient and of questionable benefit. Efficiency in ventilation must come through wider streets and courts, cleaner thoroughfares, the abolition of smoke and dust nuisances, and last, but not least, through the design of buildings, engineering work, public conveyances and their equipment on sanitary lines.

Laws have been in effect in several states which prescribe a fixed amount of fresh air to be supplied per capita in schools and theatres. These laws do not cover the standard of purity, except perhaps as expressed by the carbonic acid test, which does not measure the worst forms of contamination. They do not always define temperature and other qualities essential to secure its benefit to people. Moreover, it is almost hopeless to enforce them in the proper spirit. The urgent need to-day is to bring before the public again and again the most objectionable causes of impure air, especially those of preventable nature, and to promote sound judgment as to the logical and practical means of relief.

Natural ventilation is incidental to the design and construction of a building. Frame houses are subject to considerable leakage through the shrinking woodwork of walls, windows and doors and through their greater exposure to the air generally. It is generally sufficient in exposed wooden dwellings, at times even greater than necessary. Brick and stone buildings are also subject to more or less spontaneous ventilation, which, however, does not always meet the need. For residences and offices not unduly crowded, this may suffice with a fair exposure, but often it should be supplemented by artificial means. This implies that the building must have certain features which induce a decided movement of air, such as shafts leading from kitchen and inside rooms, also fireplace flues and vents from special sources of odor.

Mechanical or forced ventilation finds application where the number of people, excess of heat, or other conditions creating unwholesome atmosphere, can not be overcome by any other method. Theaters and crowded assembly halls, class rooms, hospitals, certain laboratories and workshops, hotel kitchens, public smoking and toilet rooms, generally need a rapid renewal of air. Of course, when subject to natural ventilation, such rooms will require less of the artificial kind. Buildings should be designed with due regard to airing and to avoid, if possible, the necessity for a mechanical system. The latter should always be considered as a sort of emergency device and reduced to the utmost simplicity consistent with the need. Moderate volumes, well applied, are better and more economical than large quantities indifferently, indiscriminately, almost criminally introduced. When designed and equipped on the right principles, buildings will be less dependent upon the uncertainties of complex machinery, incompetence or indifference of operators, parsimoniousness of owners, and all those contingencies which so often have turned a well-intentioned, but too complicated, apparatus into a lot of junk, or even a nuisance and a menace to health, instead of a means of relief.

The extreme utilization of space which is the common tendency in much of our urban architecture has passed the sanitary danger line. Unfortunately, architects do not always realize the meaning of the demands put upon them, and that those exaggerated proportions, growing out of the fight for light and air, will make sanitation more difficult and are unfair to the neighbor.

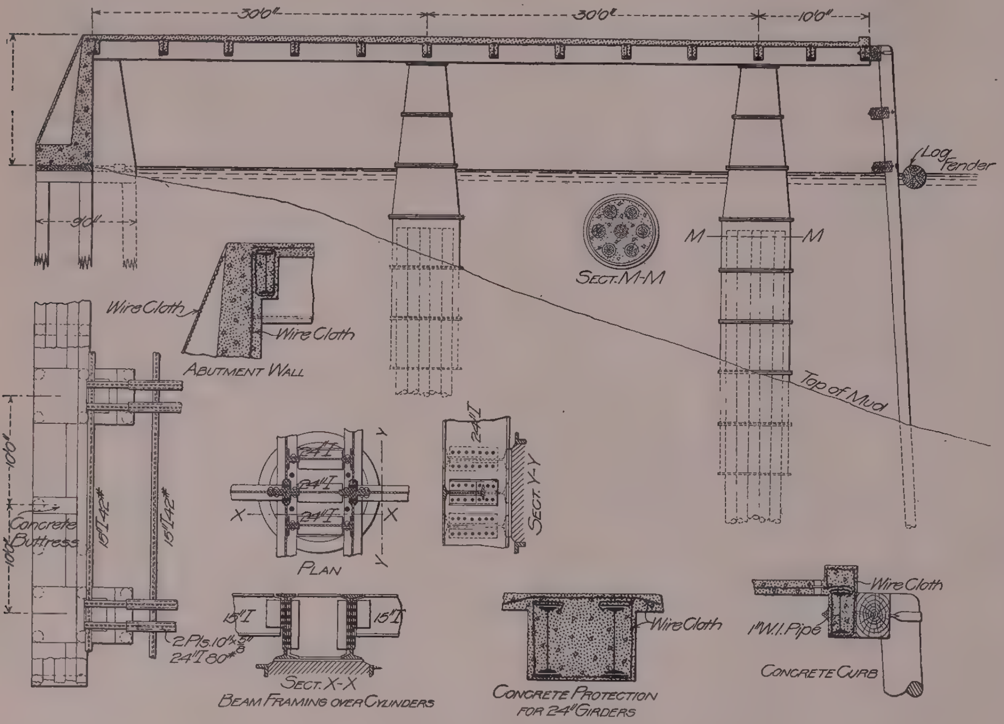
The campaign for tenement-house reform, lately rewarded by splendid results, has been a step in the right direction. Its bearing on the building laws is one of the most important benefits. The provisions calling for greater court area and other features calculated to relieve crowding and to assist natural ventilation should be made even more sweeping and extended to all classes of buildings.

To improve the housing, for rich and poor, and to make a city more healthful generally, we must aim to relieve this excessive crowding. A good beginning has been made by the fight for small parks. More of these breathing spots are needed, sorely needed. Healthy playroom for the children of those unbroken rows of flats is hard to obtain, but it must be secured, if only to break up the monotony of brick and stone and relieve it with some wholesome vegetation, cooling, purifying bits of nature. Even if limited to a single block, small parks could be utilized for schools, as is done frequently in smaller towns. This would really be the ideal way of securing their full benefit, the children profiting in the day, adults in the evening, and the neighborhood all the time. The plan of locating public buildings and schools on open squares or parks may be luxury in country towns, but it is a necessity in large cities from a sanitary point of view. This idea, once recognized and rooted, might be the wedge for a new method of securing sites of making the school the excuse, or rather the necessity, for another small park. It should at once be adopted in outlying districts where space is less expensive.

A NEW CO_2 RECORDER has been invented by Mr. A. Bayer which is now being manufactured by Mr. Julius Pintsch, of Vienna. The gas is drawn from the flues by a water-jet air pump, and is cooled before being measured for the actual test. The absorption of CO_2 is obtained by means of moistened caustic lime, and the residual gases are again cooled to a standard temperature before measuring to ascertain the contraction in volume due to CO_2 absorption. The results are recorded on a revolving drum by means of vertical lines exactly as in the well-known Ados Recorder, and samples can be tested at 6-minute intervals. The measuring vessels of the apparatus are filled with paraffin oil, and all the parts are constructed of thin sheet metal. The only attention required is the charging of the box holding the caustic lime, and the changing of the sheet on the recording drum, once every 24 hours. The apparatus has been in use at Brünn for 1½ years with good results.

The United States Coaling Wharf, Guantanamo, Cuba.

The United States Naval Station, established on Hospital Cay in Guantanamo Bay, at the eastern extremity of Cuba, is considered of the first importance as the key to strategic operations in the Caribbean Sea and as commanding all routes from the Atlantic Coast of the United States and from Europe to the eastern entrance of the Panama Canal. It is in the direct line from Boston, New York and Philadelphia to Panama and will be made the headquarters for supplies and service to the Isthmus. Plans have been developed for establishing there, a coaling station, dry dock, repair shops, stores and other improvements, aggregating $10,000,000, only a small part of which has been appropriated by Congress. The contracts have been awarded and work has been commenced on the wharf for a depot for the storage of 20,000 tons of coal and a coal handling plant with a capacity of 200 tons an hour.



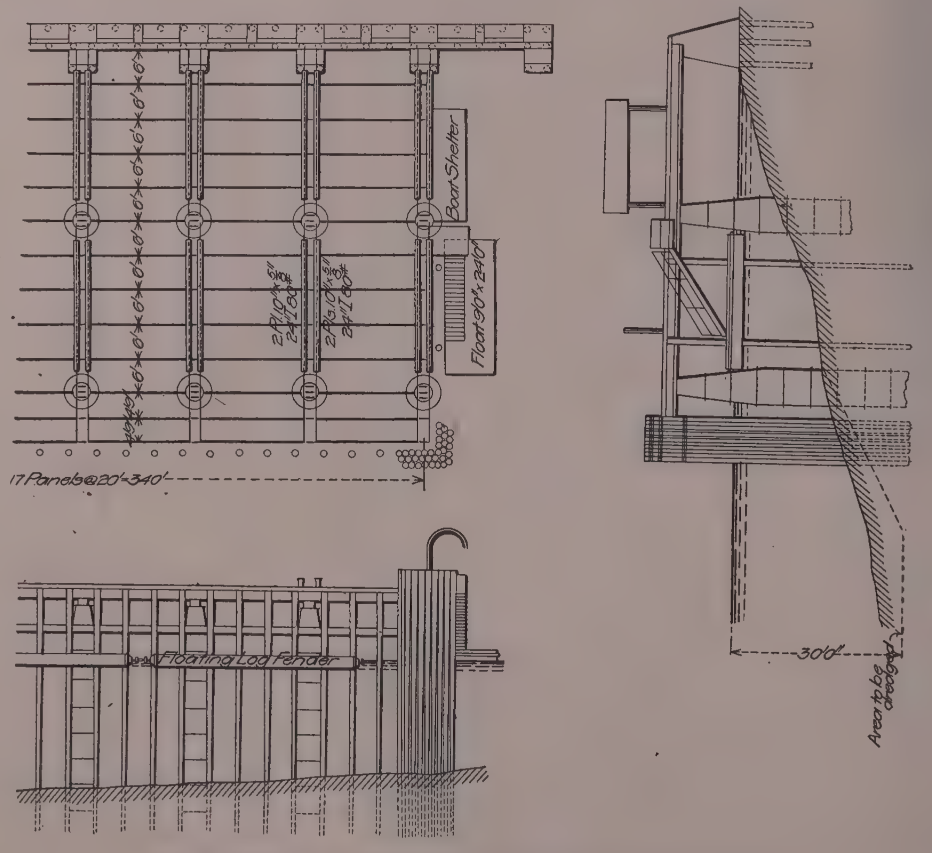
Cross Section and Details of Pier.

The island is situated in a beautiful bay with water from 30 to 40 ft. in depth, providing an excellent harbor of large size. The island has hitherto been uninhabited and forms part of a naval reservation selected by commissioners appointed by the Cuban and United States Governments. At this point the bottom is composed of soft mud overlying a stratum of harder material and sloping at a sharp angle from the shore line to a depth of about 35 feet. There is a mean tide of about 14 in., and the site is well protected from heavy winds and high seas. The site of this wharf was explored by six test borings sunk with a jet pipe, which indicated that hard material would be encountered about 65 ft. below low water.

The wharf is designed especially for durability, strength and resistance to fire and the action of the teredo. It consists of a reinforced-concrete deck 80x343 ft. with the long side parallel to the shore line, supported on three longitudinal rows of piers and protected by clusters of piles at the outer corners and by vertical fender piles and floating fenders on the sea face. It is proportioned for a live load of 250 lb. per square foot of floor surface and has a height of 12 ft. above mean low water, with the shore approach graded to that level and back-filled against a retaining wall built on the shore line. Each end of the wharf is provided with a boat shelter and a pivoted flight of stairs with support at the lower end engaging a 9x24-ft. floating landing stage.

The piers are 20 ft. apart in three longitudinal rows 30 ft. apart transversely. The shore row consists of pyramidal concrete piers with a rectangular cross-section, seated on wooden grillages supported at low-water level on clusters of six wooden piles about 75 ft. long. Vertical channels 9 in. deep are molded in the sides of the piers to receive the ends of the successive sections of concrete retaining wall 12 ft. high and 2 ft. thick at the base. This wall is made with a 5-ft. horizontal footing and an intermediate buttress 18 in. thick on the shore side and is reinforced by a sheet of Clinton electric-welded wire cloth of 4-in. mesh made of No. 3 wire. The footing of the wall is supported on pairs of wooden piles 4 ft. apart longitudinally.

The piers of the two outer rows are each made with seven 12-in. wooden piles about 75 ft. long, driven close together and enclosed with sectional cast-iron flanged cylinders 6 ft. in diameter below water level, which are sunk about 8 ft. below the surface of the mud and filled with concrete as a protection for the timber against the teredo. The piers support pairs of transverse 24-in., 80-lb., I-beam girders 30 ft. long with 10x⅝-in. top and bottom flange reinforcement plates 23 ft. long. Their webs are connected by three short transverse beams serving as diaphragms over the pier bearings. The girders are seated on ½-in. bearing plates and are secured to each pier by four 1 5/16-in. anchor bolts. The longitudinal stringers 6 ft. apart are 15-in., 42-lb. I-beams, web-connected to the girders, and carry on their top flanges the concrete floor slab 6 in. thick reinforced with a continuous sheet of Clinton wire cloth, 4-in. mesh, made with No. 3 and No. 10 electrically welded wires and finished with a granolithic surface ½ in. thick. At the outer edge of the wharf, a concrete curb 12 in. wide and 6 in. high is made integral with the floor slab and adjacent to it are 2-in. cast-iron drain pipes 5 ft. apart.



End Elevation and Part Plan and Front Elevation of Pier.

All beams and girders are completely enclosed in a solid mass of concrete, filling the interstices between the double girder beams and extending at least 1 in. beyond the metal at every point and reinforced by sheets of welded wire cloth wrapped around the girders as indicated in the sectional details. The stringer on the outer edge of the wharf is protected by a 12x16-in. Georgia pine horizontal facia timber secured to its vertical face with 1-in. bolts 4 ft. apart which pass through pieces of gas pipe bedded in the concrete. To this facia beam the upper ends of wooden fender piles, 5 ft. apart and battered 1:16, are secured by U-bolts passing through the timber and the outside stringer. The fender piles are connected by two horizontal lines of waling pieces and have chained to them a line of floating fender logs 24 in. in diameter, made in 38-ft. lengths. The wharf is provided with six heavy cast-iron mooring bitts with wide bases bolted to the top flanges of the main girders.

Construction was commenced about Nov. 1, 1906, and about 50 per cent. of the work is already completed. Piles from 75 to 80 ft. long were driven in clusters for the piers by two floating pile drivers, one of which was equipped with a boom derrick located on the rear of its pontoon and afterwards used for handling the pier concrete. After the piles for each pier were driven, the cylindrical cast-iron shells were bolted together and lowered over them. A steam hammer working in a small guide framework was seated on top of the shell and was operated until the latter was driven to a depth of about 8 ft. below the surface of the mud and encountered a harder stratum. The regular sections were bolted together with twenty 1-in. flange bolts at each joint. Above water level the shell was made with tapered sections reducing its diameter to 3 ft. at the top. After the shells were driven to position, the water and some of the mud was pumped from the interior and they were filled with 1:3:5 concrete. The shore piers, the retaining wall and the floor slab will be made in ordinary forms, and it is expected that the work will be completed in February.

Driving Cast Iron Pier Cylinders.

The wharf has been designed and constructed under the direction of Commander V. N. Nelson, of the Bureau of Equipment, and the contract was awarded to the Snare & Triest Co., New York.

A LARGE HYDRAULIC DREDGE has recently been completed for the Commissioners of Lincoln Park, Chicago. It has a capacity of 1,500 cu. yd. of material handled per hour, and is of the open end type. It digs to a depth of 33 ft., making a clear cut 175 ft. wide. The cutter is 7 ft. in diameter with 10 blades, supported on a 50-ft. frame carrying the suction pipe, and is driven by a double tandem-compound engine with 10 and 20 by 18 in. cylinders. The material is handled by a 30-in. centrifugal pump, driven by a triple-expansion engine.

The Strength of Lime Mortar.

An extended series of tests, undertaken to determine the factors which affect the strength of lime mortar and the importance of each, has been made in England during the past year by Mr. W. J. Dibdin, from whose paper published by the Royal Institute of British Architects, these notes have been taken: The by-laws of the London County Council regarding the composition of mortar contain no reference to strength, but merely specify that it shall be composed of freshly burned lime and clean, sharp sand or grit, without earthy matter, in the proportion of one part of lime to three of sand or grit, by volume. The results of Mr. Dibdin's tests indicate that mortars made in direct contradiction to these by-laws may develop a higher compressive strength than those which follow the one-to-three rule. The lime used in the tests is termed "best gray lime" and the sands used were secured from local sources.

In investigating the effect of the fineness of the sand about 160 tension and 260 compression tests were made on briquettes having a breaking section of 1 sq. in. In the compression tests these briquettes were cylindrical in form, 1 in. high and 1.12 in. in diameter, giving a sectional area of 1 sq. in. In each case the tests were arranged in groups, five sets to a group and three tests to a set. A different size of sand was used in each group. The variation in the sets in each group consisted in using different volumes of sand to one part of unslaked lime as: 1 to 1; 2 to 1; 3 to 1, etc., up to 5 to 1. The three briquettes in each set were tested when possible at periods of fourteen days, one month, and three months, respectively, after their manufacture.

At first a group of tests was made with unwashed sand made up of grains varying in size from 1/20 to 1/30 in. Other groups of tests were made with washed sand grading as follows: ⅛ to 1/16 in.; 1/16 to 1/32 in.; 1/32 to 1/40 in.; 1/40 to 1/50 in.; 1/50 to 1/75 in., and 1/75 in. to smaller. The mortar made with unwashed sand grading 1/20 to 1/30 in. in the proportion of 1:1 developed at the end of three months an average compressive strength of 150 lb. per sq. in. When the sand was increased to two, three and four volumes, in the same group, the compressive strength became 92 lb., 52 lb. and 53 lb., respectively. In the subsequent tests where washed sand, graded as before indicated, was used it was found that in all cases where the sand was larger than 1/50 in. the mortar was stronger when only one or two volumes of sand were used, these two mixtures being about equal in strength, but when the sand was finer than 1/50 in. the compressive strength of the various proportions was about equal at the end of three months, ranging from 58 to 66 lb. per square inch. The tests for tensile strength are in the same ratio and clearly indicate that with these sands an excess of lime in contravention of the by-laws was a distinct advantage. While the effect of the variation in the size of the sand grains is not in all cases consistent there seems to be a decided tendency toward a decrease in the compressive strength of the briquettes as the size of the grains decreases. The 1:1 mixture which shows an average strength, at the end of three months, of 150 lb. for the 1/20 to 1/30-in. sand, shows values for the other sizes as follows: ⅛ to 1/16-in., 152 lb.; 1/16 to 1/32-in., 126 lb.; 1/32 to 1/40-in., 104 lb.; 1/40 to 1/50-in., 110 lb.; 1/50 to 1/75-in., 58 lb. While the results of these tests do not seem consistent enough to warrant a general assertion they indicate that probably the maximum compressive strength of the mortar is developed long before the expiration of three months, perhaps within one month. In several cases the briquettes tested at fourteen days for compressive strength showed values nearly as high and in a few instances higher than those tested after three months.

Over six hundred tests, about equally divided between tension and compression, were made with various sands and various mixtures of sand and lime to determine the effect of clay in the mortar. The manner of conducting the tests was exactly similar to that used in the tests for effect of fineness of sand. The clay used was the same as that naturally present with ordinary and otherwise clean sand. It was ground so as to pass 1/75 in. and was added in percentages of 2½, 5, 7½ and 10. As before the maximum compressive strength seemed to be developed in about one month. The variation in strength developed by the different mixtures was not nearly so pronounced as before, and in the groups where 7½ and 10 per cent. of clay was added the 5 to 1 briquettes were about as strong, at each of the three periods and in both compression and tension, as the richer mixtures.

When 2½ per cent. of clay was added the briquettes of that group developed compressive strengths which in no case exceeded 156 lb. at the end of three months, and averaged about 100 lb. With an addition of 5 per cent. the strength at 3 months shows a fairly consistent decrease from 233 lb., as the average of the three 1 to 1 briquettes, to 108 lb. as the average of the three 5 to 1 briquettes. With additions of 7½ and 10 per cent. the briquettes of all mixtures exceeded, in general, 200 lb., averaging about 225 lb. after a single very low value had been thrown out.

In the discussion of the paper Mr. Dibdin is reported by Mr. Searles-Wood to have privately expressed the opinion that the clay had no chemical effect of importance and was of value only as it increased the density of the mortar.

As it might be assumed that the influence of clay artificially added would not be the same as that naturally present, experiments were made in which briquettes were prepared with the natural sand as received, and after the removal of the clay by washing. In general the effect of removing the clay was a decrease in the compressive strength developed, the washed sand mixtures showing not much more than half the strength of the corresponding ones made with the natural sand. Two sands were washed. The percentage of voids was increased by washing, in one case from 23 to 34, and in the other from 28.6 to 30. A very fine white sand without any natural clay was tested at the same time and gave low tensile and compressive values. In connection with these results of the clay experiments Mr. Dibdin suggests that it must be remembered that mortars made with sand containing clay undergo a certain degree of shrinkage on drying, and that it is a question how much shrinkage may be permitted in order to secure the resulting addition of strength. As the greater part of the shrinkage takes place within the first twenty-four hours after the "setting" of the mortar, according to Mr. Dibdin, it will doubtless be of less importance than that which might occur later.

To determine the effect of delay in using mortar after it is mixed, briquettes were tested which were made of new mortar, and mortar one, two, three, seven and eleven days old, respectively, the proportion of sand and lime being in all cases 3 to 1. From these tests it appears that up to seven days there is an increase in strength, but after that time, that is, after the mortar has once set, the effect of a second breaking up is distinctly detrimental, though even then better results were obtained than at any time before the first setting. The crushing strength at one month gradually rose to 116 lb. per square inch with a seven-day-old mortar and fell to 83 lb. when the mortar had been allowed to stand eleven days before being used.

In regard to the tests on the raw materials, Mr. Dibdin says: "It was thought that it would be interesting to repeat the tensile and crushing tests upon the lime only and on the sands. These tests were, therefore, made as a matter of interest, and as affording general comparison. The results, as might be anticipated, gave impracticable strengths."

While no extensive determinations were made of the effect of varying the percentage of voids in the sand, the data secured indicates that the strength of the mortar probably increases as the percentage of voids decreases, however no general statement can be made in regard to this.

When clean sand was used spalling occurred with over-limed mortars; in other cases the blocks burst in the crushing tests without notice. When clay was used with the sand, spalling steadily occurred. The method adopted for determining the pressure at which spalling occurred was to observe the time at which the spalling commenced and also that at which crushing took place. As the pressure was steadily increased throughout the test by the constant rate of addition of a stream of shot, a simple calculation gave the pressure at which spalling occurred. The results secured do not indicate that the pressure at which spalling occurs has any consistent relation with that at which failure takes place.

In conclusion Mr. Dibdin points to the tests as indicating that the strength of a mortar depends far more upon the physical character of the materials employed than has hitherto been fully realized and suggests that tests be employed in each case to determine the desirability of a given mortar rather than adhering to arbitrary proportions.

The Cost of Suction-Gas Power is discussed in the "Electrical Review" by Mr. R. Weaving, who gives figures based on the working of a plant under his charge. It consists of three gas-driven generating sets of 50-kw. each, which have been running over two years for operating machine shops. The engines are direct-coupled to generators, and are governed by hit-and-miss gear, with an additional throttle-governor on the gas inlet. The gas for the three engines is derived from one suction plant. The fire is banked at week-ends, and put out only at 2 months intervals. A month's running showed the following: Coke, 22¼ tons, £13 18s. 2d.; water, 106,500 gal., £2 4s. 5d.; wages, £16 15s. 4d.; oil, £1 13s. 6d.; sundries, 15s.; scrubber and purifier renewals, 5s. 6d.; interest and depreciation, £22 10s.; total, £58 1s. 11d. The coke burned per horse-power-hour was 2.22 pounds.

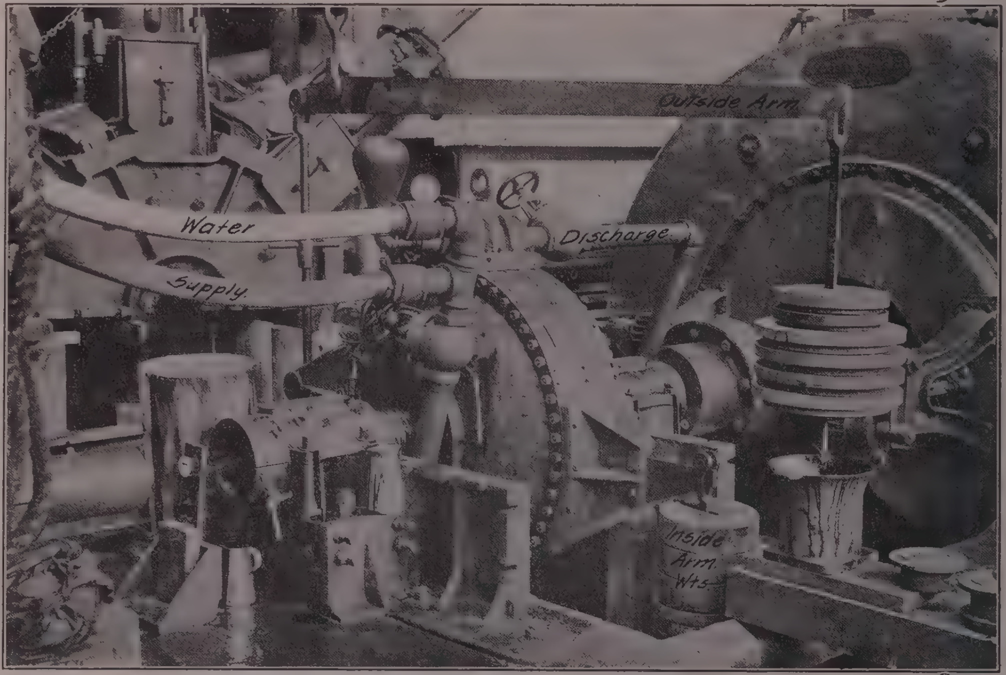
Modern Water-Wheel Testing.

By Prof. Charles M. Allen, Worcester Polytechnic Institute.

Water-wheels of all sizes and kinds have been tested at the Holyoke Testing Flume for years and are still being tested there in a most satisfactory manner. For comparative purposes and under similar conditions these tests serve their purpose well and their influence has been great in the development of the modern efficient turbine. However well a wheel may show up under test made as just described, it may or may not give equally good results after installation. That depends entirely upon the conditions of setting and requirements of performance. If the wheel is given a good setting and is allowed to run at its proper speed, then it will perform its rated work, which can be accurately computed from the original tests. If, on the other hand, it is not given a fair setting and is required to run at too high a speed (which seems to be almost universal modern practice) it will fall down both on power and efficiency, the amount of each depending upon the departure from the normal conditions.

Within the past few years, there has come a demand from engineers, water-wheel builders, and owners of hydraulic plants for some means of accurately testing wheels of large powers after they have been installed, in order to determine the horse-power and efficiency under the normal working conditions. The Alden absorption dynamometer has been developed to meet these demands. The principle of the dynamometer is so familiar that only a brief description will be given. It is a form of Prony brake and consists of several smooth circular revolvable cast-iron disks, keyed to the shaft which transmits the power; a non-revolvable housing having its bearings upon the hubs of the revolving disks, and a pair of thin copper plates in contact with each cast-iron disk, the plates being integral with the housing. Through a system of piping, water under pressure is circulated through chambers between each unit, consisting of a disk and its copper plates, and between the outer plate at either end and the wall of the housing. The water pressure is regulated by an automatic valve. Another system of piping circulates oil for lubricating the surface of the copper plates next to the revolving disks. The oil, which in the large machines is impelled by a pump mounted on the housing, enters the chamber at the circumference and is forced along radial grooves of the disks to the hub and completes its circuit through hose connections to the pump.

When the dynamometer is in use, water passes through the chambers of the housing and between the several units of plates and disks and by its pressure tends to force the plates against the sides of the revolving disks. This pressure increases the friction between the disks and plates and offers resistance to the rotation of the disks. The construction resembles that of a constantly slipping friction disk clutch. The resistance to turning imposed by the friction plates and disks is balanced by the weighting apparatus.



Counterbalancing a Dynamometer Replacing a Grinder

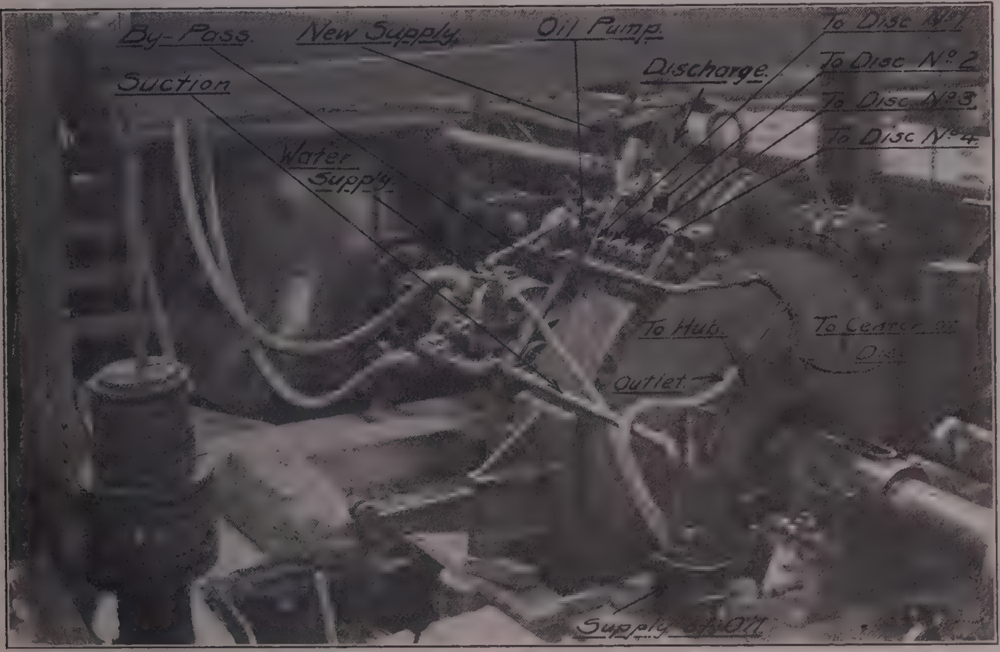
The power transmitted from the wheel under test tends to rotate the housing, which tendency is counteracted by the weights. The housing is kept from rotating beyond prescribed limits by stops on either side of a lever arm bolted to the housing, while the balance is being obtained. The weighing apparatus by which the power absorbed is measured is delicately adjusted on knife-edge bearings. There are two sets of scales, which may be called the outside and inside scales. The outside scale indicates one horse-power for one pound weight per 100 revolutions per minute. The inside scale indicates one horse-power for ten pounds of weight per 100 revolutions per minute. The outside scale serves not only to assist in balancing the load—that is, to weigh it—but also to take the weight of the housings from the bearings on the hub of the revolving disks.

It is possible to take not only the weight of the dynamometer off from the bearings, but also the weight of the shaft. There have recently been made several tests on wheels developing over 2,000 h.-p., where the entire weight of the dynamometer and shaft, about 13,000 lb. total, was counterbalanced so nicely that the nearest required running bearing was that of the water-wheel some 7 ft. away from the dynamometer. In other words, when the load was on the dynamometer, it was as if it were placed on an overhanging shaft about 7 ft. from the nearest bearing. This point is an interesting one in mechanics and shows that the wheels tested in place can be given a fair treatment under test.

The largest dynamometer built at the present time consists of four 60-in. disks and has a power-absorbing capacity of 1,500 h.-p. at 100 r.p.m., or about 3,000 h.-p. at 200 r.p.m.

The capacity of the dynamometer is limited by the amount of heat that can be transmitted through the copper plates. This depends upon the range of temperatures and the amount of the circulating cooling water. The capacity is also affected by the kind of lubricating oil used. A cheap grade of cylinder oil has been found satisfactory for this work. A system of forced lubrication is essential to smooth operation.

The dynamometer just described recently held a load of from 2,000 to 2,300 h.-p. during a series of tests on a pair of turbines for over eight hours of continuous running. The reason for making so long a run was because the weir for measuring the water used was situated in the canal above the turbines and time was required to allow conditions to become constant. It may be of interest to note that this weir was standard, with end contractions, and was 73 ft. long. During the tests, when the wheel gates were wide open, the quantity used by the wheels required a head of 2 ft. on the crest of this weir.



Dynamometer of 3,000-H. P. Capacity at 200 R.P.M. Installed for Test.

The largest power ever absorbed at one time by these dynamometers was 4,100 h.-p. developed by a pair of turbines under a head of 110 ft. at a speed of 225 r.p.m. These turbines were used to furnish power for a pulp mill. There were six grinders situated on either side of the turbines, making twelve in all. The grindstones nearest the turbines were removed and two dynamometers put in their places. The amount of work required to make such tests is comparatively small when the amount of power is considered. Two units of approximately 4,000 h.-p. were tested inside of three days. In pulp mills it is difficult to know how much power the wheels are developing. It is not always safe to base the estimate on quantity of pulp, as there are many varying conditions of stones, wood, etc.

Several tests of large power have been made in hydro-electric stations, in which case the generators are set aside and the dynamometer mounted on the wheel shaft, usually in place of the half coupling. To give an idea as to what are sometimes found as actual running conditions in plants, one test showed the wheels to be giving the power as called for by the contract, but if they had been run at 200 r.p.m. instead of 225 r.p.m., the power would have been increased from 2,000 to 2,300 h.-p., which means that the wheels were wasting 300 h.-p., and thus lowering the efficiency. On another test, it was found that the normal working speed was so high that if the entire load were removed the wheels did not "run away." The power and efficiency were between 30 per cent. and 40 per cent. lower than they should have been.

Several tests have been made which show that if the wheels are given a "fair setting" and the speed properly chosen, they will agree closely with the computed ratings made from the tests at the Holyoke Flume. One test of a pair of wheels made after installation agreed so closely with the computed results from the Holyoke tests of the individual wheels that the curves showing the relation of the horse-power and efficiency to the speed gate opening of the pair, came between the curves of the separate wheels transferred to the same head basis. The term "fair setting" means that the water should be brought to the wheel with a low velocity, the draft tube should be designed especially for the particular conditions and should be air-tight; the shaft of the wheel should not be larger than necessary; the wheels (if a pair and center discharging) should not be set too closely together; the bearings should be kept in line, etc.

The brake testing of water-wheels of large powers is to-day an accomplished fact, and there seems to be no mechanical reason why the largest units built could not be thus tested with this form of dynamometer, as it is only a question of the number and diameter of disks.

Generating Power With Waste Heat is a feature of the Yorkrun plant of the H. C. Frick Coke Co., in Fayette County, Pennsylvania. One hundred bank ovens are connected to a flue divided into two sections, each of which receives the heat from fifty ovens. Each section of the main flue varies from 41 to 62 in. in diameter and is made of three rings of brick, the lining being silica brick, the middle fire brick, and the outer hard-burned common brick. There are two boiler houses, in each of which are three 300-h.-p. Stirling water-tube boilers. Between each two boilers a flue 53 in. in diameter is brought in from a connection with the main flue, and at the side of each of the two end boilers in each building is a flue 40 in. in diameter. These four flues are joined at right angles to a rectangular flue, 12 x 96 in. in section which extends under the boilers back of the bridge wall. Any oven or any boiler may be cut out of the system by dampers and coal can be supplied to the boilers when desirable by means of larry tracks.

Centrifugal Pumps at the La Grange Water Works.

The North Shore Electric Co., which does an electric service business in the majority of suburban towns around Chicago, has recently placed deep well centrifugal pumps in its combined water and electric light plant at La Grange. One has been in operation in regular service for several months, and another is to be installed in an adjoining well. The pump is of the three-stage type, 13 in. in diameter over all and located 80 ft. below the surface in the well. The suction extends down 30 ft. more, making a total depth of 110 ft. from which water can be drawn. The motor, which is at the surface, drives the pumps through a long vertical shaft. The well in which it is placed was formerly pumped by a compressed air outfit, and in order to accommodate the centrifugal pump it was necessary to ream out the top of the well to a depth of 120 ft. The cost of this reaming on one well was about $1,500. As the upper part of the well was drilled through solid rock, it was not provided with a casing; consequently there was no expense for removing a casing when the reaming was done. The total depth of the well is 2,014 ft. The ordinary depth of water when pumping is about 63 ft.

The centrifugal pump was made by the Byron Jackson Machine Works, of San Francisco. It is driven by a Westinghouse three-phase, 440-volt induction motor running 1,120 r. p. m. The pump discharges into an 8-in. pipe which takes the water to the surface. In the middle of this 8-in. pipe is a 4-in. pipe and inside of the 4-in. pipe is the driving shaft. At 8-ft. intervals in the 4-in. pipe is a babbitted bearing to keep the vertical shaft in line, and the shell of this babbitted bearing serves also as a coupling for the 4-in. pipe. Every other bearing is steadied within the 8-in. pipe by means of cap screws with jam nuts placed 120 deg. apart around the bearing. These cap screws are adjusted to hold the bearing in center with their heads against the inside of the 8-in. pipe and the jam nuts are then tightened.

At the top of the well there is a ball bearing which takes the weight of the armature shaft and pump runners while the pump is starting up. After it is started the weight is taken by a hydraulic bearing supplied with water under pressure from the water-works mains. This hydraulic bearing consists simply of a disk on which the weight is placed and under which a film of water is forced, so that the weight is carried by this film of water. The shaft cannot be raised by the water pressure very far because the increased opening caused by the raising of the shaft would immediately cause a drop in the water supply pressure on account of the restricted inlet for the water. This deep-well pump discharges into a reservoir at the surface.

The pump now in operation is delivering from 400,000 to 450,000 gal. of water from one well per day. By weir measurement it pumps at the rate of 428 gal. per minute. The rated capacity of these pumps working against 100-ft. head is 350 gal. per minute.

For raising water from the surface reservoirs to the standpipe two motor-driven centrifugal pumping sets are provided. Each set is driven by a 50-h.-p. Westinghouse, three-phase, 440-volt induction motor running 1,120 r. p. m.; on each end of the motor shaft is a jaw clutch coupling by which it can be connected to a two-stage, horizontal shaft Byron Jackson centrifugal pump. The arrangement of piping and valves is such that either pump can be operated alone or the two pumps can be operated in multiple for ordinary pumping into the standpipe. The maximum pressure against which they must pump when the standpipe is full is 54 lb., and the average pressure is about 50 lb. In order to put a fire pressure of 90 lb. on the mains, it is only necessary to connect these two pumps in series and close the valve between the mains and the standpipe. The rated capacity of each set of two pumps is 700 gal. per minute pumping in parallel against 138-ft. head and 350 gal. per minute pumping in series against 221-ft. head. This makes an extremely flexible arrangement. For ordinary pumping, at present writing, it is customary to run one motor driving one pump the entire 24 hours, except during the peak load in the evening and for about an hour every afternoon. This of course runs the motors somewhat underloaded, but since the point of maximum efficiency on an induction motor is considerably less than the maximum load it can carry without overheating, the motor is not running at an inefficient point. The practice in case of fire is to connect the two pumps in series and let them discharge into the standpipe. As long as they are discharging into the standpipe, the pressure, of course, does not rise above normal. When the pumping station is notified by the chief of the fire department to put on fire pressure, it is only necessary to close the valve between the water mains and the standpipe and the pressure will at once rise to 90 lb. As a matter of fact, the pumps connected in series when not delivering much water will raise the pressure to 110 lb. This was thought undesirable on account of damage to plumbing in the houses. Therefore, to prevent the pressure ever getting so high a safety valve bypass has been provided by which a certain amount of water is allowed to flow into the reservoir whenever the pumps raise the pressure above 90 lb.

The current supply for this La Grange plant comes from a large power station of the North Shore Electric Co., at Maywood, a suburb several miles north of La Grange. When the present changes are completed the load will be carried regularly from the power house at Maywood over the 10,000-volt transmission line. A part of the old steam plant will be retained as a reserve to give pumping service in case of any long-continued storm which might cause interruption of the transmission line. None of the steam pumps will be retained, however. The centrifugal pumps will be relied on entirely for the pumping, as both the deep well pumps and the standpipe pumps are in duplicate. A 100-kw., three-phase, four-wire generator with a high-speed engine and a boiler will form the steam reserve at this substation. The steam reserve will be, therefore, available for either lighting or water pumping purposes.

The installation has been made under the immediate direction of Mr. J. M. Strasser, who is the superintendent for the North Shore Electric Co. at La Grange, and was manager of the property for many years before it was purchased by North Shore interests. Mr. Frank J. Baker is general manager of the North Shore Electric Co., and Messrs. Sargent & Lundy are the consulting engineers.

The Water Supply of Paris.

The water supply of Paris, France, is obtained and delivered through works which, since 1861, have been the property of the city. The company directly in charge of the reservoirs, filters, mains, etc., has carried on the business of the water supply on behalf of the city. The water company is now seeking a renewal of its contract for twenty-five years, and M. de Selves, who has investigated the matter and made a report, advises the municipal council to prolonged the contract, since, according to his estimate, it would cost the city authorities about $100,000 per year more to operate the plant than to have it run by the company. Gross receipts of about $4,400,000 a year are earned by the company at a cost of about $2,240,000. According to M. de Selves it would cost the city not less than $3,200,000 to arrange for the distribution itself. The reasons given for this estimated increase are that the laborers employed by the city earn higher wages than those employed by the water company, and the city probably could not collect from its creditors as successfully as a private company. Moreover, the city would have to hire additional officials. The unpaid water bills of Paris for a period of fifteen years, during which the total charges for water approached $50,000,000, amounted to a little less than $50,000.

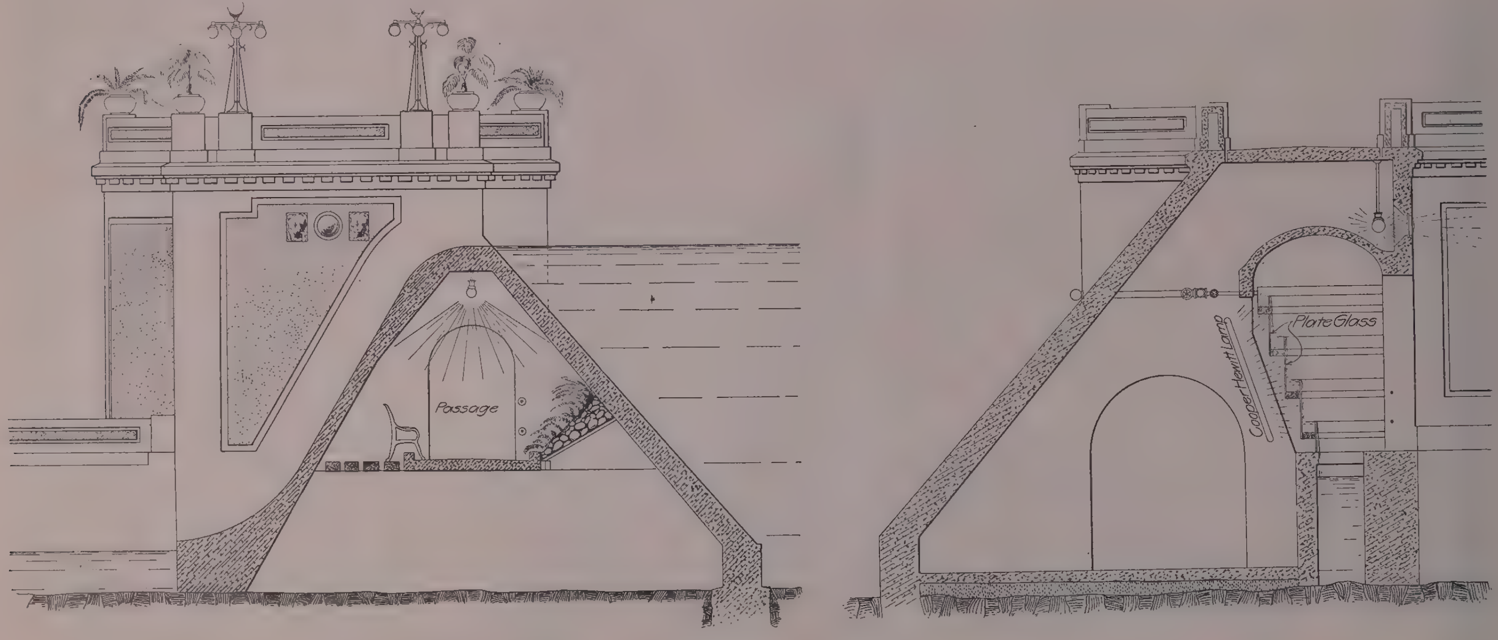
LIME CONCRETE was used several centuries ago in Spain, according to Mr. Thomas E. Collcutt, president of the Royal Institute of British Architects. Near Algeciras there is a very beautiful aqueduct with piers about 3 ft. 7 in. square which, on cursory examination, appear to be built of blocks of conglomerate stone. Mr. Collcutt dug into this material and found it to be lime concrete made with pebbles and broken stone. The age of this aqueduct is placed by various authorities at between 300 and 800 years.

A Remarkable Dam at Dellwood Park, Ill.

By Howard S. Knowlton.

There has recently been completed at Dellwood Park, Ill., a pleasure resort on the lines of the Chicago & Joliet Electric Ry., some rather unusual dam and bridge construction of the reinforced concrete variety of construction. The work includes two dams and two foot bridges, and the accompanying illustrations show how successfully the problem of ornamental design was solved. Both dams were designed and constructed by the Ambursen Hydraulic Construction Co., of Boston, the consulting architects being Messrs. Putnam, Cox & Skinner, of the same city. The bridges were designed by the American Railways Co., engineers and contractors for the park, but were built by the Ambursen Co.

A deep ravine heavily wooded with oak runs through the grounds of the park, and a small stream runs through the bottom of this ravine during winter and spring. The two dams were built to create artificial lakes for landscape effects, boating and skating. The original plans contemplated three bridges across the ravine, but the peculiar features of the Ambursen dam construction enabled the third bridge to be omitted.



Sections through Spillway and Abutment of the Large Dam at Dellwood Park.

The cross-sections of the two dams are similar in general, but the dam nearest the lower end of the park is larger, and is built with the object of allowing foot passengers to walk beneath the deck and spillway. The design of the lower dam is unique and was specially devised to attract the attention of passengers on the neighboring railroads, primarily, of course, to advertise the attractions of Dellwood Park. The design consists mainly of two approximately T-shaped abutments made hollow, the upper decks of which are connected by paths to the shores, constituting promenades and observation points for the lower pond. The interior of one buttress on the north side of the stream was utilized for the location of an electric fountain. This consists of a series of plate glass troughs; water is fed into the upper one, it overflows, and a thin film of water falls into the next trough below, and similarly through the series of troughs to a pool in the bottom of the dam. The pool is drained into the stream below the dam. Cooper-Hewitt mercury vapor arc lamps are located behind the glass troughs. The fountain is placed directly back of the large semi-elliptical arch shown at the right hand end of the front view of the dam.

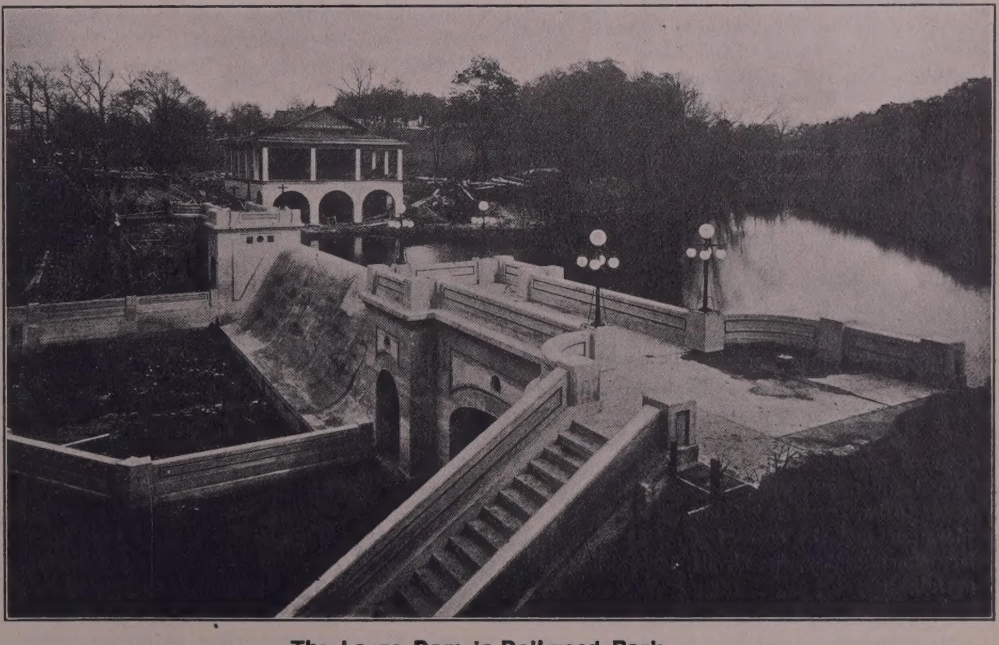
Into the heads of the two T-shaped abutments lead arched entrances and from the interior of these abutments openings lead into the interior of the dam. Similar openings are cut in each of the buttresses which support the deck and apron of the dam. A floor is laid through these openings above the level of the back water, so that a complete discharge of the stream takes place from one side to the other. The interior of the dam is lighted by electricity, and the niches or recesses between the buttresses are decorated with potted plants or seats, making an attractive grotto for the use of patrons of the park. This interior is one of the unique and charming features of the structure.

Typical Bridge in Dellwood Park.

At the extreme north end of the dam a concrete stairway leads from the lower level to the top of the bank, and a similar flight of stairs, which does not show in the illustrations, leads from the bottom of the stream to the bank at the other end. The exposed surfaces of the abutments were finished by scouring with sandstone and by bush hammering. Ornamental wrought iron lamps were placed upon some of the concrete posts, space being left on others for potted plants.

The upper or smaller dam is about 40 ft. long, and this, with the two foot bridges, was finished partly by sand stone blocks and water as a scouring medium, and the panels were bush hammered. All the work was placed with simple and inexpensive forms, and all ornamental work was cast in place.

The steel reinforcement was accomplished with Johnson corrugated bars, and particular care was taken to provide for temperature changes so that no unsightly cracks should develop. In this, the structures appear successful. Buttresses and wing walls are designed with 1:3:6 concrete, and water-bearing decks, crests, apron and all exposed surfaces were 1:2:4 concrete. Construction began March 28, 1906, and was completed Sept. 10. The two bridges have one and three arch spans respectively, and were specially designed to harmonize with their surroundings.



The Large Dam in Dellwood Park.

A GAS-DRIVEN ELECTRIC STATION, recently put in operation in Madrid, Spain, is one of the largest installations of the sort yet in operation. It consists of six Nürnberg engines of 2,000 h.-p. each direct connected to three-phase, 3,000-volt generators. Gas is supplied by a plant made by Messrs. Duff Brothers & Co., Liverpool, Eng. Spanish bituminous slack coal is used, which is mostly fine dust and contains 17 to 25 per cent. of ashes. There are six producers of 2,009 h.-p. each. The gas is first treated for the recovery of ammonia and is then cleaned until all traces of tar are removed.

Progress in Pumps.

Presidential Address of Mr. Dabney H. Maury before the Illinois Society of Engineers and Surveyors.

In almost every important line of useful research or endeavor, a few vital and fundamental facts were known and made use of as far back as records run. In each such line there came to us, therefore, almost from the dark ages, an existing "state of the art"—for the basic needs of man—food and drink, raiment and shelter—were the same then as now, and had to be met in some way. Except for a few occasional flashes of invention, which shone all the more brilliantly because of the surrounding darkness, the progress of the "state of the art" was, as a rule, unilluminated until within the last century. Since then inventions and improvements have succeeded each other with astonishing rapidity.

Progress in pumps has been no exception to the general rule of progress in other lines. Devices for lifting water by manual, or animal, or water power were in use many centuries ago; and the application of steam to pumping marks the beginning of the later and more rapid development of the art of raising water.

Thirty years ago the choice of a waterworks pump was little more than a matter of simple arithmetic. If the desired capacity, the head and the steam pressure were known, the dimensions of steam and water cylinders could be quickly figured, and the problem was then practically reduced to getting the best possible prices on two or three different makes of steam pumps.

If coal was comparatively dear in the particular locality, and the pump was a fairly large one, a compound pump would be purchased; otherwise a simple pump answered the requirements.

A pump having a capacity of 5,000,000 gal. per 24 hours was then considered large, and a test duty of 65,000,000 foot pounds per 100 lb. of coal was thought to be a satisfactory performance for a direct-acting engine, while crank and flywheel engines were expected to show duties of from 75,000,000 to 85,000,000 foot pounds.

The battle between the direct-acting engine and the crank-and-flywheel engine was on in earnest; the former having the advantage of lower first cost, while the latter excelled in economy of fuel.

In 1882 the first Gaskill crank and flywheel high-duty engine showed a test duty of over 112,000,000 foot pounds per 100 lb. of coal. The late Henry R. Worthington, who invented and developed the direct-acting steam pump, had always been its most prominent advocate; and in 1885 the Worthington Co. brought out for the first time its now well-known high-duty attachment, consisting of compensating cylinders designed to take the place of a flywheel. The first Worthington compound condensing high-duty engine is credited with a test duty of over 79,000,000 foot pounds per 100 lb. coal, and subsequent engines of the same type soon exceeded 100,000,000 foot pounds.

Hardly had this last improvement in the direct-acting engine pushed it once more to the front, when the E. P. Allis Co., of Milwaukee, built the first of the now famous vertical triple expansion single acting pumps, after the designs of Mr. Irving H. Reynolds. This pumping engine has since been copied by almost every builder of large engines in the country, save the Worthington Company.

So far as steam economy is concerned, this type of engine has broken all previous records, and stands to-day in this respect far ahead of all other steam pumping engines.

The size of the modern pumping engine has increased from a maximum of five or six million gallons per day, twenty years ago, to that of 40,000,000 gallons; and the total aggregate daily capacity of triple expansion engines now in use runs into billions of gallons.

While the last quarter-century had been producing such remarkable advances in steam pumping engines of large size and high duty, it was no less prolific in results in the field of smaller devices for lifting water.

The larger units are naturally to be found in use where the water is taken from a source capable of yielding large quantities, such as lakes or the larger streams; the smaller units generally find their field of usefulness where the supply has to be drawn from wells.

Thirty years ago the waterworks engineer who had to lift water from more than 25 ft. below the level at which he could set his pump, had in most cases, nothing better at his command than the single-acting deep-well plunger pump, of which the Cook deep-well pump was the best known example. The duty of this class of pump was usually very low—probably not more than six or seven million foot pounds per 1,000 lb. of steam, and its capacity was limited to a few gallons per minute.

To increase the capacity of the deep-well pump, and to reduce the shocks caused by the starting and stopping of the long water column, the vertical double-acting steam cylinder connected to tandem or differential water plungers, was brought out; and then belt-driven or geared power heads connected to similar plungers, were developed. The latest improvements in this direction have taken the form of mechanisms designed to provide a slow up stroke and a quick downward return for each of the tandem water plungers, so that at least one plunger is always lifting water, and the upward motion of the water column is never stopped. These devices have not only greatly increased the smoothness of operation of deep-well pumps and their capacity, but have also resulted in great improvement in economy by the substitution for the long steam cylinder, taking steam full stroke, of power taken either from a flywheel engine using steam expansively, or from a gas engine, or from any type of motor.

In the meantime, however, the necessity for securing from wells greater quantities of water than could be pumped by any available type of reciprocating pump, resulted in a number of other inventions. The most notable of these was, for a time, the air lift. This was widely introduced in small pumping plants, for it gave immediate and very spectacular results.

The enormous stream gushing from the end of a well-pipe was always sure to impress the uninitiated who did not stop to think that much of the escaping stream was air or spray, and who had not the ability to figure out the subsequent expense of operation. Where the existing wells are small and numerous, and where the quantity of water to be drawn from them is the principal desideratum, and the cost of pumping is a secondary consideration, the air lift has still a field of usefulness.

But improvements have been going on in wells as well as in pumps, and modern practice is discarding the small well with its fine strainer for larger units with strainers that will not rust out or become clogged. These changes have made for the introduction, in the larger sizes of driven wells, of other and simpler forms of pumps. One of these, of the old screw, or propeller, type, adapted to driven wells of from 8 to 12 in. or more in diameter, can be driven from the top by belt or direct-connected motor, and will deliver large quantities of water, but has comparatively low efficiency. The last few years have witnessed the development, here and abroad, of several forms of deep-well turbine pumps, which should mark a decided advance in the art of deep-well pumping. Such pumps have already lifted at the rate of over a million gallons per day from a 10-in. well, against a head of between 70 and 100 ft., and with an efficiency of over 50 per cent. Their simplicity of construction, and the fact that they can be driven from the top by any type of engine or motor, add greatly to their practical usefulness.

Electricity, and the gas or oil or gasoline engine, have of recent years become important competitors to be considered in the choice of motive power for any pumping plant of moderate size. Each has its obvious advantages, and where the choice shall rest must depend entirely upon the local conditions.

Enough has already been said to show that the waterworks engineer of to-day must consider many things and make many estimates on cost of installation and subsequent operation before he can feel that he has chosen the best possible pump for the case which he has in hand; but the latest and by far the most important developments have not even yet been mentioned.

One of these is the steam turbine, already successfully applied to the generation of electric power, the total installations already aggregating over a million horse-power.

Another is the improved centrifugal or turbine pump.

The third is the gas-producer engine.

The remarkable adaptability of the steam turbine to direct connection to electric generators, and the tremendous and constantly increasing output of electric power, have created a demand for the steam turbine so great that its makers are many months behind their orders, and most of them have had no time nor incentive to build turbines for direct connection to the modern turbine pump. One firm has, however, brought out a regular line of steam turbines of from 15 to 300 h.-p. direct connected to high lift, high speed, centrifugal pumps. Recent as has been their development, centrifugal and turbine pumps have already often exceeded 70 per cent. efficiency, and efficiencies of over 80 per cent. have been claimed in particular instances, and would seem to be within reasonable reach in the near future.

No one can now question the wonderful practical success of the steam turbine as a motor. Its proper adaptation to an efficient turbine pump is only a question of time.

Gas-producer plants are now being installed under guarantee of one brake horse-power for one pound of anthracite coal per hour; tests of 300 h.-p. units at the Louisiana Purchase Exposition at St. Louis gave one brake horse-power for about 1¼ lb. of bituminous coal; and a test of a 35-h.-p. gas engine driven by producer gas and belted to a centrifugal pump, gave a net duty in water lifted of 89,000,000 foot pounds, per 100 lb. of anthracite pea coal.

A comparison of the first cost and the duty of the best modern triple expansion reciprocating steam pumping engine with those of the steam-turbine-driven turbine pump, and the gas-producer pumping plant, would result about as follows:

Assuming a capacity of 10,000,000 gal. daily against 100 lb. pressure, which would correspond to 400 water horse-power:

A vertical triple expansion condensing pumping engine of the best modern type, could be erected, complete with foundations, boilers and pipe connections, but without buildings, for about $70,000. This plant would consume about 1.4 lb. of coal per water horse-power per hour, this figure being based on the best performances of such engines under test.

A steam-turbine-driven turbine pump of equal capacity can be erected complete, with foundations, boilers and pipe connections, but without buildings, for about $30,000; and, based on the average of a large number of tests of the steam turbine, and assuming 75 per cent. efficiency for the turbine pump, such a plant should deliver one water horse-power for about 1.8 pounds of coal.

The gas-producer plant, complete with foundations, gas-producer gas engine, turbine pump and connections, but without buildings, can be had for about $50,000; and should deliver one water horse-power for about 1.35 lb. of coal per hour.

In the average waterworks pumping station there must always be a plant of a capacity at least double the average daily consumption. This means that differences in estimated annual coal bills should be divided by two before they can be fairly capitalized for the purpose of comparing the results of investments in the different plants.

Bearing this fact in mind, it can readily be seen that except when coal is exceedingly high, the reciprocating steam pumping engine will in most cases prove a more expensive investment than the turbine plant; while in the near future, the gas-producer pumping plant is likely to prove a better investment than either of the others.

The Recent Use of Invar Tapes for the Measurement of Primary Bases.

Since the discovery of the alloy of nickel and steel called "invar," from invariable, which possesses a very small coefficient of expansion, its use for precise measuring apparatus has been tested very carefully. Most of these investigations have been made under the direction of Mr. C. E. Guillaume, of the International Bureau of Weights and Measures at Paris. His experiments having proved the metal to be fairly stable, the Coast and Geodetic Society decided to try it for the measurement of primary base lines.

In December, 1905, the Survey purchased from Mr. J. Agar Baugh, London, England, several ribbons of the invar tapes, 6.3 mm. in width, 0.5 mm. in thickness and 53 meters in length, which were prepared for measuring tapes in the instrument division of the Survey. An account of the work done with them was recently given in a paper by Messrs. O. B. French and John F. Hayford before Section D of the American Association for the Advancement of Science, from which these notes were taken.

During 1906, the Survey measured six base lines, using on each base three invar tapes, in daylight (standardized at the National Bureau of Standards), and also three steel tapes, at night (standardized in the field). Several pieces of the invar tapes, tested at the Bureau of Standards, showed a tensile strength of 100,000 lb. per square inch (about one-half that of steel tapes), with the elastic yield point about 70 per cent. of the tensile strength. The tapes were tested for considerable ranges of temperature, reeled and unreeled a large number of times, and also tested for continued application and removal of light loads, without showing any change in length. The co-efficient of expansion of the invar tapes was found to be 0.0000004 per degree Centigrade, or 1/28 that of steel.

The steel and invar measures of the six bases were computed independently. The differences between them are small, the largest being 1:300000 (3 mm. per km.), and the average about 1:500000. The probable errors of the lengths of the bases from the steel measures are more than double those from the invar measures. The final probable errors of the bases, giving the invar double weight, are between 1:250000 and 1:500000 (0.4 millimeter and 0.2 millimeter per kilometer).

In 1900 the Coast and Geodetic Survey demonstrated that steel tapes gave practically the same accuracy as bar apparatus with one-third of the cost. It is now shown that the invar tapes give results considerably more accurate and economical than the steel tapes.

Book Notes.

It is a pleasure to notice the appearance of such a good book as Prof. L. M. Hoskins' "Textbook of Hydraulics." Although there are several good volumes on the subject, the manner in which it is discussed in this work is marked by a logical sequence of statement that will probably appeal strongly to many teachers. It is a common experience in class-room work in hydraulics to discover that even bright students fail to appreciate the distinction between what is rational, what is assumption, and what empirical in the various formulas that are deduced. There is also an absence of any real appreciation of the common basis of all problems in the steady flow of liquids, in Bernoulli's theorem. Both these defects should be overcome by a careful use of Prof. Hoskins' manual. After a statement of definitions and fundamental principles, the phenomena of hydrostatics are described. The flow of water through orifices is next taken up, and then comes a very good chapter on the theory of energy applied to steady stream motion. This is further amplified in a chapter on the application of Bernoulli's theorem to various problems on the assumption of no loss of head. In some cases the results of the problems are useful, for the actual losses are small, while in other cases the problems simply illustrate general principles. The application of the theorem, taking account of losses, is then explained, and the causes and amounts of these losses are stated. The next chapter gives the application of the theory when a pump or motor is used. The frictional loss of head in pipes and special cases of pipe flow are next taken up, and the discussion is particularly good in that the empirical nature of working formulas and tables is clearly shown. The next section of the book opens with the application of Bernoulli's theorem to streams of large cross-section. There are separate chapters on uniform and non-uniform flow in open channels, and a rather short one, for engineering classes, on the measurement of discharge. The closing section of the book opens with a chapter on the dynamic action of streams, followed by one on the theory of steady flow through a rotating wheel. The various types of turbines and water-wheels are next described. The theory of the impulse turbine is explained in the following chapter, and the tangential water-wheel is described in the next one. The theory of the reaction turbine and the construction of turbine pumps are taken up in the last two chapters. There are appendices on the steady flow of a gas and on relative motion, and three pages of conversion factors. (New York, Henry Holt & Co.)

In view of the general interest in centrifugal pumps at the present time, the appearance of Mr. Fritz Neumann's "Die Zentrifugalpumpen" is decidedly timely. The great widening of the field of usefulness of this type of pump, particularly the increase in the head against which they operate, is one of the noteworthy changes of present-day engineering. It has come about so quickly, however, that comparatively little information on the subject is available. The author has been a specialist in turbine water-wheels, and his attention was drawn to the design of centrifugal pumps by noticing in a testing laboratory the poor design of the blades of several pump runners. This led him to study the theory of such pumps, particularly those portions relating to the shape of the blades, carrying this through from the basic principles in an independent manner. The book is in five parts. In the first he presents the theoretical analysis of these machines, and in the second their consumption of power and efficiency. The third part is a short explanation of the regulation and classification of centrifugal pumps. The fourth part, which is of most use to the designer, is a discussion of the proper shape of the blades, and is illustrated by examples. In the final section, there are descriptions of centrifugal pumping plants installed by several leading European builders; these all show remarkable efficiencies and their design demonstrates the value of the author's methods. (Berlin, Julius Springer, 8 marks.)

Some time ago Mr. F. Lavis contributed a paper on the field practice of railway location to the "transactions" of the American Society of Civil Engineers, which attracted much attention as a statement of good methods followed in a branch of engineering of which little information is available in printed form. He has since then elaborated that valuable paper into a 278-page book entitled "Railroad Location, Surveys and Estimates." The idea of the author has been to take the subject up at the point where most locating engineers have to, namely, with a general route within more or less wide limits and a maximum grade given. Accordingly the book covers the methods of conducting surveys in the field, after the general route has been decided on; how the party should be organized and handled; short, expeditious methods of getting results; making estimates for the comparison of different lines; and the preparation of the maps, profiles and estimates of the final line. The recommended practice is that developed on the Choctaw, Oklahoma & Gulf R. R. by Messrs. F. A. Molitor and E. J. Beard, both of whom are now engaged in Philippine railway work, but the author has also drawn on his experience with other roads in the United States and Latin-American countries. The book is particularly adapted to the use of students in engineering colleges, and it goes into detail to an extent that the experienced engineer, who has forgotten his school troubles, may consider somewhat unnecessary. The general method of locating a line from a reconnoissance, preliminary survey and paper location is first explained, and the nature of reconnoissance surveys is taken up at some length. The organization of the party and the equipment which it is advisable to have are discussed, and there are drawings of portable tables and other special furniture which the author has found useful. The chapter on the field work of the preliminary survey is particularly useful as a clear statement of present practice, which is very different from that of even comparatively recent times which regarded this work as preliminary location. In the latter case an attempt was made to locate the line in the field, while at the present time the general rule is to make the preliminary work a topographical survey of a strip of country about 600 ft. wide; the notes are immediately mapped and the final location is drawn in on the map and then transferred to the ground. The mapping, the location of the road on the maps, and the staking out of the final line are explained in great detail, like the preliminary surveys, and if these two chapters are read by the college student while he is studying his course in railway curves he will find both subjects are made much more interesting. The chapter on the location of suburban rapid transit railways will be of interest even to men thoroughly familiar with work in the open country. Electric traction where the trains are equipped with motors under multiple unit control has introduced decidedly different governing conditions from those ruling on steam lines. It is also often necessary to conduct the surveys in such a way as to furnish no hint concerning their purpose, while their accuracy must be much greater than is needed for most railway surveys. The author has been in charge of considerable work of this nature, which he explains quite fully. The chapter on estimates and tables of quantities furnishes a large amount of information and valuable diagrams never brought together before in such a handy form. There is also a useful chapter on surveys in tropical countries, and a collection of tables and formulas used in railway surveys. (New York, Myron C. Clark Publishing Co., $3.)

Letters to the Editor.

Safety on Railways.

Sir: Permit me to suggest to your readers that the widespread criticisms of the prevalence of railway rear-end collisions is a subject so much in evidence in public discussion that engineers should take some steps to see they do not receive blame for conditions over which they have no control. The civil engineering department of a railway does not often have more than a mere nominal connection with the signal engineer, and is rarely consulted regarding the features of the telegraph block system which is in general use. The recent criticisms in influential journals to the effect that civil engineers have not looked after the public safety properly is based on a misconception of what their duties are.

It seems to me that the subject is one of such great importance that it ought to be discussed openly by some such representative body as the American Society of Civil Engineers or the New York Railroad Club. The apparent present policy of silence is not a good one, for unless those who are competent to talk with full knowledge do so, then those without such knowledge will take up the subject and the railroads will not only be face to face with financial investigations by the federal government, but will also be exposed to injudicious legislation forcing upon them essentially useless "safety appliances." It is growing common in railway circles to-day to say that the only safety appliance worth anything on roads of heavy traffic is an increase of trackage at congested sections. This may be so in some places, but in the present state of suspended animation of railways, while waiting to ascertain if Congress can and will find a way to scale down their capitalization, it is not likely much second and third track will be built.

The fact ought to be brought out emphatically by somebody in a position to give his words influence with the public, that the telegraphic block signal system is a good one when it is properly conducted and the train rules are also lived up to rigidly. It works well in Great Britain, and the only reason it does not work well here is because the railway employes are not under such good discipline and subject to such searching public examination in case of accident as there. In the case of some serious rear-end accidents that happened recently I have seen no mention of any promptness on the part of the train crew of the forward train in getting signalmen out. I have seen many times the most culpable slowness shown in sending back flagmen from trains stopped in a block, and when I have asked why more haste was not taken the answer has always been that the train was protected by a block. The clearest expression of this most important feature of safe railway operation that I ever saw was the admirable editorial contributed to your issue of Jan. 7, 1905, by Mr. Joseph Ramsey, Jr., and I will bring this letter to a close with the following extracts from it:

"The minute a train runs inside a block section, the trainmen feel that they are protected against any rear-end collisions, and that there is no need for flagging on their part, as the block signal will protect them until they get out of the block. . . . If we had laws in this country similar to those of some foreign countries, which hold the employe, be he officer or trainman, legally responsible for violations of rules and for accidents resulting therefrom, it would be the best safety appliance law which could be passed, and if the district attorney of any district were required by law to take up such cases, the effect would be to prevent a large number of accidents which are now occurring solely through carelessness and neglect of rules. . . . If every trainman, block signal operator or other employe whose duty connects him with train service, or whose violation of a rule might result in an accident, would impress upon his mind that in the event of a violation of a rule and the taking of chances resulting in the death of any one, he was guilty of murder, it seems to me he would be more inclined to comply with the rules, even if he broke the owner or caused some negligent or inefficient officer to lose his job. No efficient railroad officer will wink at the violation of train and block signal rules."

Very truly yours,
Chicago, Feb. 1. Traveler.

An Impossible Economy in Power Plants.

Sir: I note in your issue of Jan. 19 a paragraph suggesting "a possible economy in power plants" by the utilization of the heat contained in the circulating water as it is discharged from the water jackets and the intercoolers of air compressors. I regret to say that the suggestion has in it no touch of practicability. You can't utilize the heat, because the heat is not there to be utilized. The specific heat of air and of water are so very different that a little water suffices for the cooling of a considerable volume of air. As a matter of fact and observation, the temperature of water as it flows through a water jacket or intercooler is only slightly elevated. Both water jacket and intercooler would be failing in their function if temperatures of "100° to 150° Fahr." were occurring in the water which overflowed. Intercoolers upon Ingersoll-Rand compressors will discharge the air at temperatures not more than 10° above that of the circulating water. If the water as it enters is, say, 60° it must therefore be discharged below rather than above 70°, and as there was an Ingersoll-Rand compressor in the plant described in your article, we may be very sure that if water jacket and intercooler were doing their duty the circulating water was only slightly warmed.

Although the water thus apparently abstracts but little heat, its important service, especially in the intercooler, is not therefore to be belittled. A great change is effected in the temperature of the air as it passes from the low pressure to the high pressure cylinder, its volume is proportionately reduced and also the power consumed for the final compression.

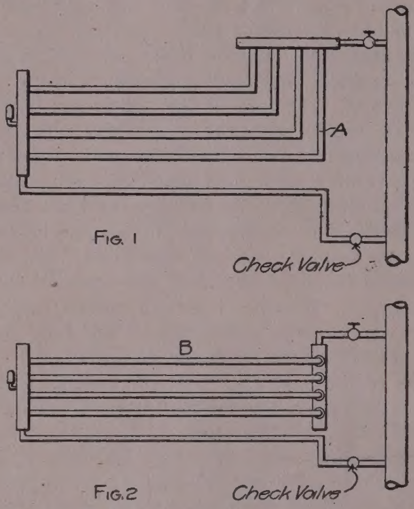
In the Kingsland plant the water of condensation, with the condenser circulating water to make up the losses, must have provided a boiler supply at a temperature considerably higher than that of the circulating water from the compressors, so that the heat of the latter could not have been of any practical avail. Of course this water had to be discharged somewhere and it naturally was turned into the general supply, but it is not easy to discover how there could have been any appreciable advantage in the little heat which it carried. Frank Richards.

Trouble with Heating Coils.

Sir: In response to the query of "Heating Engineer" in your issue of January 26, 1907, concerning "Trouble With Heating Coils," I would suggest the following: It is evident that the reason that no steam flows from the top header into radiating pipes *A* and *B* in Fig. 1 and 2 respectively, is that the steam enters this header from the supply pipe in the form of a jet. The jet form of this entering steam is not broken up until it has passed the entrance to the pipes in question. As a consequence, all the steam is supplied from the top header to the remaining pipes of the system and whatever steam enters pipes *A* and *B* must come from the return header.

The reason for this entering steam jet is probably because the proper proportions between the size of the supply pipe and the area of the radiating surface for this method of connection have not been observed. In other words, the amount of steam condensed in the radiating pipes is so great that the velocity of steam entering the supply pipe is necessarily very high.

As a remedy for the trouble, I would suggest the following: First, increase the size of the supply pipe, or second, let the supply pipe enter the header at the side of the header instead of at the end.



A Heating Problem.

Of the two methods, the first would probably not be very effective, although the velocity of the entering jet may be considerably reduced. If, however, the header be tapped at the side as is suggested in method No. 2, the steam jet will enter at one side of the header and will strike the other side and be broken up before any steam enters any of the pipes. For equal distribution in all the pipes, probably the best point for tapping the supply pipe would be the center of one side of the top header.

"Would-be Heating Engineer."

Reinforced Concrete in the Jamaica Earthquake.

Sir: In your paper of Oct. 6, 1906, page 367, first column, you state that "probably the best example of concrete house construction on this side of the Atlantic is the home of Mr. Alfred Mitchell, near Port Antonio, Jamaica." You doubtless spoke better than either of us knew, as you will see by the enclosed letter which we received, entirely unsolicited, from the owner, Mr. Mitchell.

Yours truly,
Aberthaw Construction Co.
Boston, Feb. 2.

Mr. Mitchell's Letter.—"I write to you to let you know that the house at Folly and all the other concrete erections upon the place have passed through the late earthquake without showing the least crack or shake. From the accounts you will get in the papers, which are all derived from sources desirous of minimizing the violence of the shock upon the north side of the island, you will get a very false idea of it. Perhaps the relation of the following facts will enable you to appreciate the degree of movement to which we were subjected.

"Owing to misjudgment of the proper time of repairs, when we arrived here we found very little water in our reservoir, which was soon consumed. An unparalleled drought followed and we have not had a drop of fresh water since about Jan. 1. Consequently we have used our bath tubs all over the house as tanks for salt water, for use in flushing the water-closets. At the time of the earthquake all bath tubs put to such use were about half full of sea water. In every case, a considerable part of the water was splashed over the sides or ends of the bath tubs upon the floor of the bathrooms, where it was swabbed up by our servants after the shock. The rumbling noise which momentarily proceeded the first and heaviest shock and which seemed like the passage of a train of cars over the roof drove us out of doors, and it seemed as though the house must be shaken to pieces. But we soon returned to it to ascertain what damage had been done, and found only the bathroom floors flooded, as I have stated."

Effect of Oil on Concrete.

Sir: Will you kindly inform me what the effect of oils, fuel oil, petroleum, etc., is on concrete? The case in question is the advisability of lining a fuel oil storage reservoir with concrete. The reservoir is in earth lined with puddled clay, which is only partially effective, and as a means of preventing loss a concrete lining is proposed.

I should be pleased to know your opinion in this matter and to see a discussion of it in the "Letters to the Editor" department of the Record if it is of sufficient interest.

Very truly yours,
Los Angeles, Jan. 24. H. V. Clotts.

[It is generally held that concrete is injured by oil to such an extent that it cannot be used as a tank for holding the latter. If any reader knows of a case where a concrete tank has been employed to hold oil for any length of time, a memorandum of the facts is requested.—Editor.]

A Large Water Power Development is in progress at Nine Mile bridge on the Spokane River near Spokane, Wash. The work includes the construction of a masonry dam and power house and the ultimate installation of turbines and generators capable of producing over 20,000 h.-p. The dam when completed will be 75 ft. wide at the base and 60 ft. high, and will contain over 17,000 cu. yd. of concrete and stone. The dam and power house, the latter forming part of the dam, will be 455 ft. long. The power house is 110 ft. long, 114 ft. wide, and 111 ft. high. Provision is made for the installation of four turbines of about 6,000 h.-p. each, direct connected to generators, but at present only two units are to be installed. At the dam site the river runs through a gorge about 100 ft. deep and 300 ft. wide. The depth of the channel was about 15 ft. and the stream ran close to the west bank. A row of timber cribs about 200 ft. long and 20 ft. high was sunk along the east bank. Cross cribs were then sunk in the stream, perpendicular to those previously placed, thus forming a cofferdam 150 x 200 ft. and diverting the stream to the east side of the gorge. These cribs were made as light as possible with brush and earth, and the water which now leaks in is kept down with four pumps having an aggregate capacity of 12,000 cu. ft. per hour. Within the cofferdam the power house is being built. Its foundations are carried down about 30 ft. below the normal water level. The walls of the power house will be carried up to the flood height before the water is turned back into its old channel. The front wall of the power house is provided with by-pass openings through which the water will flow while the dam is under construction and which can be readily closed when necessary. The construction is in charge of Mr. F. M. Sylvester, manager for Sanderson & Porter, engineers and contractors, who have the contract for the work.